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Compressed Air Magazine

GRAVEL FROM THE HEAVENS

Bucket of aerial tramway dumping aggregate for big Australian dam

(SEE INDEX PAGE AND PAGE 96)

AUSTRALIAN OFFICIAL PHOTO BY J. FITZPATRICK

VOLUME 59 • NUMBER 4 NEW YORK • LONDON

COMPRESSORS RUN BETTER

WHEN lubrication is *exactly suited* to the operating conditions, air compressors run better. And, as efficiency goes up, maintenance costs go down.

You see, no *one* oil can satisfactorily meet *all* compressor operating conditions. The oil you'd use for one set of conditions might not be the right oil for another set.

That is why there is *a complete line* of Texaco air compressor oils — to enable you to get an oil that's *exactly right* — regardless of the operating conditions, or the size and type of compressor.

Let a Texaco Lubrication Engineer help you make the proper selection. Just call the nearest of the more than 2,000 Texaco Distributing Plants in the 48 States, or write:

The Texas Company, 135 East 42nd Street, New York 17, N. Y.

TEXACO

TEXACO Air Compressor Oils

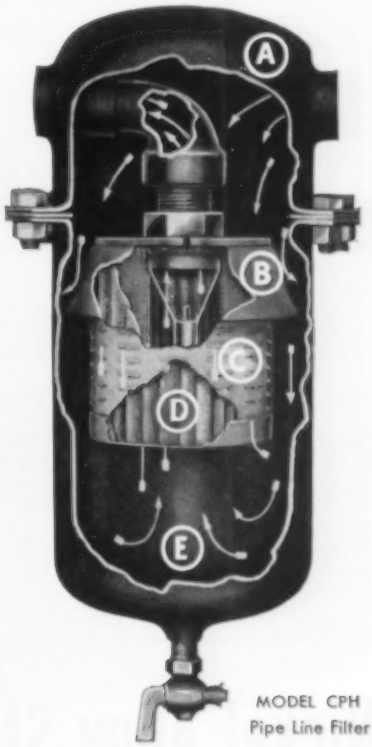
FOR ALL OPERATING CONDITIONS

TUNE IN . . . METROPOLITAN OPERA radio broadcasts every Saturday afternoon. See newspaper for time and station.

Circle 1A on reply card

Clean, Dry Air

WITH STAYNEW PIPE LINE FILTERS



MODEL CPH
Pipe Line Filter

ASSURES CONTINUOUS OPERATION OF COMPRESSED AIR EQUIPMENT

And Here's Why . . .

Air operated tools, instruments, processes and pneumatic controls have one thing in common . . . they *thrive on clean, dry air.* With few exceptions, all breakdowns, repairs, and loss of productive time can be avoided by filtering air and other gases through Staynew Pipe Line Filters. Wherever air must be kept clean and dry for industrial equipment, filter it with Staynew.

Send for complete illustrated catalog on Staynew Pipe Line Filters. Write today!

Representatives in Principal Cities

- **A.** Heavy pressed steel head and body.
- **B.** Deflector cup.
- **C.** Louvred housing.
- **D.** Radial fin filter insert.
- **E.** Large capacity base.

*MODEL CPH	Horizontal Pressure Type
MODEL CP	Vertical Pressure Type
MODEL CVH	Vacuum Type
*MODEL AAPH	Absorption Type
MODEL HPH	High Pressure Type

*Also available in swing bolt construction for easy inspection and servicing.

DOLLINGER PROTECTOMOTOR STAYNEW FILTERS

DOLLINGER CORPORATION

7 Centre Pk., Rochester 3, N. Y.

ALL TYPES OF FILTERS FOR EVERY INDUSTRIAL NEED

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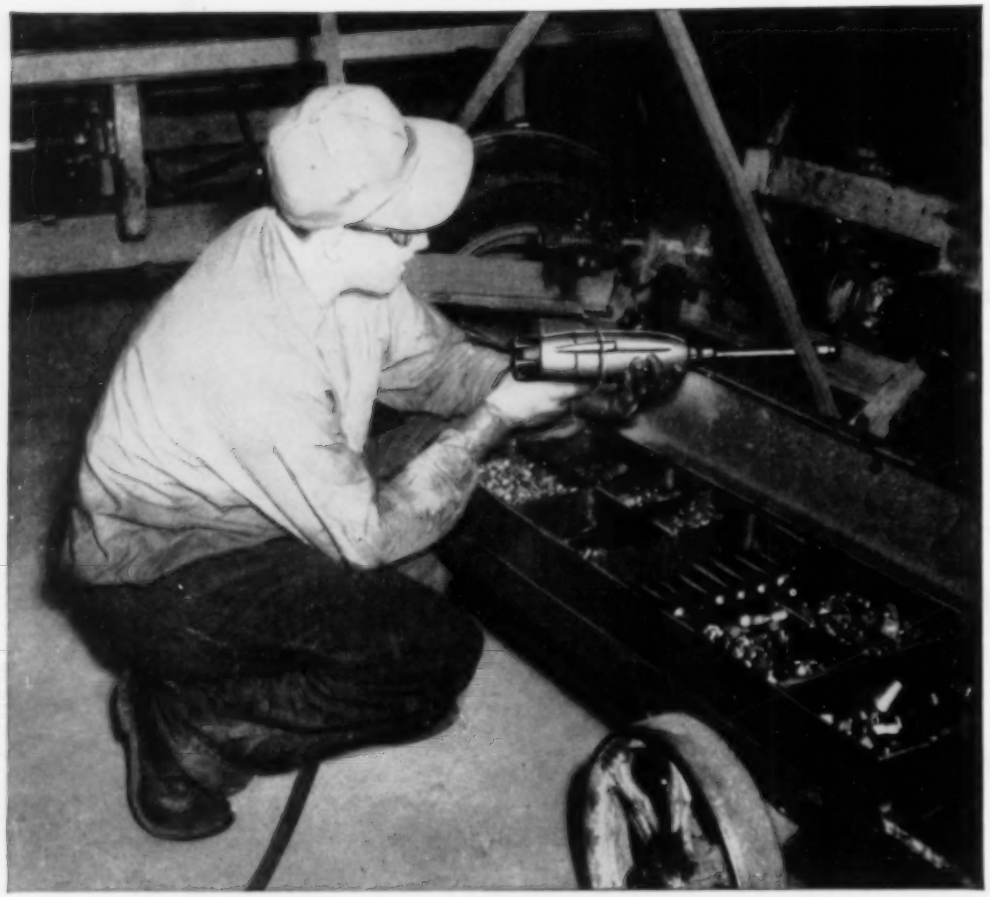


Nickel Alloy Steel Parts help the Impactool . . . a product of Ingersoll-Rand . . . deliver dependable performance with a minimum of maintenance and replacements. View above shows I-R Size 5080 Impactool in use, bolting up main frame assembly of a combine with ½" to ⅝" bolts.

Nickel Alloy Steels used in Ingersoll-Rand Impactools *withstand terrific pounding . . . resist wear*

No ordinary metals could withstand the thousands of powerful rotary impacts per minute encountered by vital parts in the IMPACTOOL shown here . . .

Regardless of shock-loads encountered when engaging frozen nuts, bolts and studs, this powerful little tool stands up because hammer, anvil, arbor and other critical components are fabricated from steels that can take the beating.

Ingersoll-Rand engineers specify carburized nickel alloy steel for the impact mechanism. This steel provides ample impact strength at high hardness levels. And they specify cylinders in nickel alloy iron, to obtain essential strength, wear resistance and ready machinability.

The many standard grades of nickel alloy steels available make it possible to select one which provides a combination of properties to meet almost any specific requirements.

So, whenever your metal problem is a tough one, think of nickel alloy steels, and send us details for our suggestions.

THE INTERNATIONAL NICKEL COMPANY, INC. 67 WALL STREET NEW YORK 5, N. Y.

Circle 3A on reply card

"You see POWELL VALVES everywhere!"

Not surprising when you realize that Powell makes more kinds of valves and has probably solved more valve problems than any other organization in the world. And this has been going on since 1846.

Wherever flow requires dependable control, there's the place for Powell Valves—available through distributors in principal cities. Made 1/8" to 30" and 125 pounds to 2500 pounds W. S. P. Bronze, iron, steel and corrosion resistant alloys. On problems, write direct to The Wm. Powell Company, Cincinnati 22, Ohio.

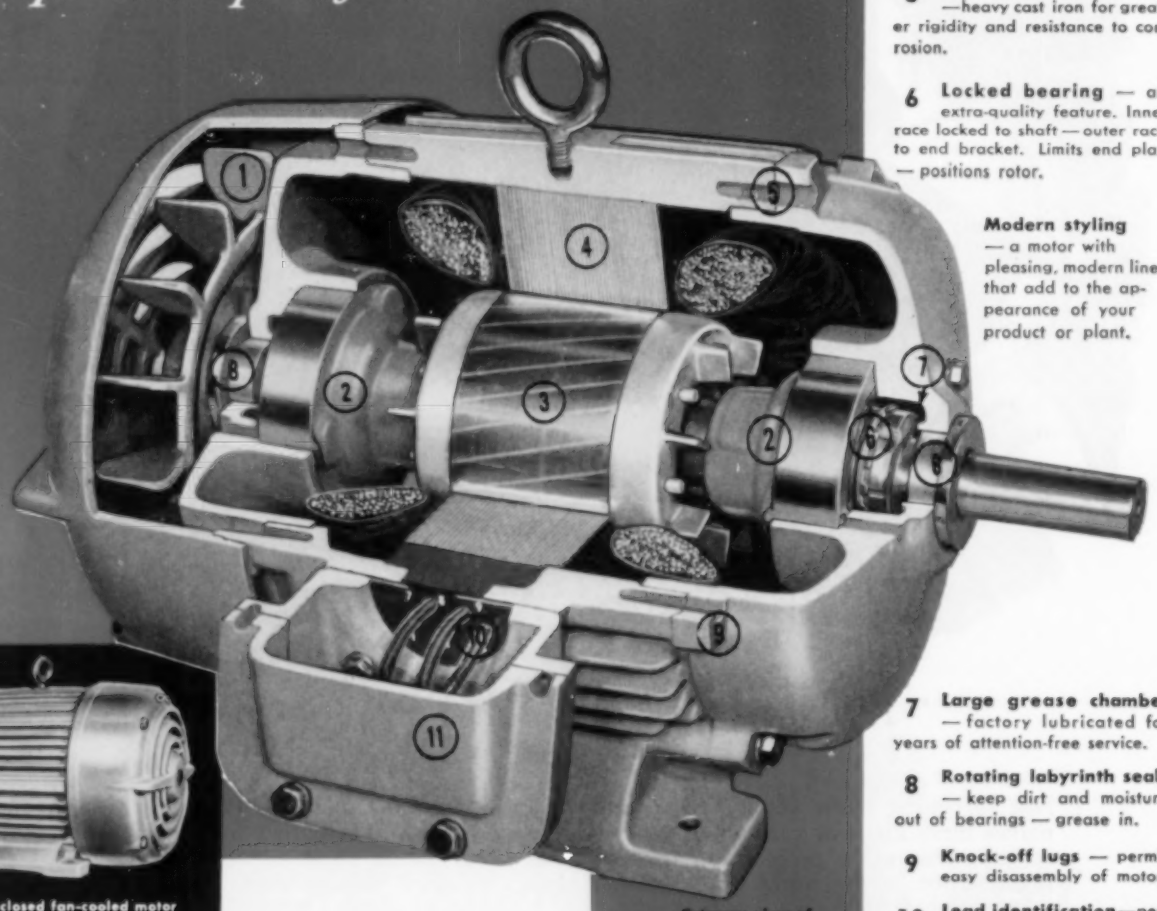
CONTROLS FOR THE LIFE LINES OF INDUSTRY

Powell Valves 108th year

Here's the inside story of

the NEW L.A. *Line*

...your BEST enclosed and explosion-proof motor BUY



Cutaway view of explosion-proof motor

Totally enclosed fan-cooled motor

1 **Fan** — efficient, non-sparking fan. New aerodynamic design for more effective cooling.

2 **Inner bearing cartridges** — lock bearings to end bracket and form explosion-quenching seal along shaft.

3 **Indestructable cast-aluminum rotor**—dynamically balanced with fan for smooth, quiet operation.

4 **Stator** — prewound stator core utilizes Formvar wire insulated with a new Alkyd Asphalt Resin insulating varnish.

5 **End bracket and housing** —heavy cast iron for greater rigidity and resistance to corrosion.

6 **Locked bearing** — an extra-quality feature. Inner race locked to shaft — outer race to end bracket. Limits end play — positions rotor.

Modern styling — a motor with pleasing, modern lines that add to the appearance of your product or plant.

7 **Large grease chamber** — factory lubricated for years of attention-free service.

8 **Rotating labyrinth seals** — keep dirt and moisture out of bearings — grease in.

9 **Knock-off lugs** — permit easy disassembly of motor.

10 **Lead identification**—permanent, positive lead identification spacer in conduit box.

11 **New split conduit box** — rugged cast-iron conduit box diagonally split for easy connection.

This is the completely new L.A. totally enclosed fan-cooled and explosion-proof motor. Every feature in this new line is designed for easier installation, longer service life, less maintenance and attention. You get the full benefit of the new NEMA standards in a smaller, more functional, completely modern design.

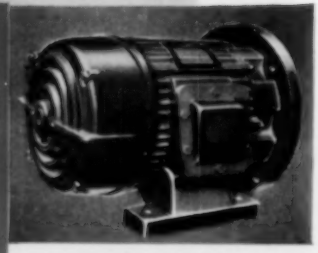
Your nearby Louis Allis Sales Engineer can show you all the reasons why these motors perform better and longer on your tough jobs — why they give you maximum resistance to corrosion wherever you need this extra protection. Call him today.

THE LOUIS ALLIS CO.
MILWAUKEE 7, WISCONSIN

LA-103

Vertical NEMA D-flange motor

NEMA C-flange motor



NEMA D-flange motor

We specialize in SPECIAL MOTORS— *and* PROMPT DELIVERY, TOO

There's a Louis Allis special motor for your toughest application. Whatever electrical or mechanical modifications you need, check first with Louis Allis.

When you have FLUID LINE TROUBLES... and need help in a hurry

When HOOK-UPS are being planned or altered

CALL YOUR HANSEN REPRESENTATIVE

Quick-connective couplings are the main business of the Hansen representative, but so are fluid line circuits. By the very nature of his job he is thoroughly familiar with practically every type of hook-up. He knows what works—and why it does.

When you need help in a hurry—either when you run into difficulties—or when fluid line circuits are being planned or altered—make use of his know-how. You'll welcome the help that he can give you.

HARRY A. NEFF
The Neff Engineering Co.,
Fort Wayne, Indiana

Provides practical engineering service based on years of close contact with hundreds of pneumatic and hydraulic installations in the State of Indiana.

THOMAS H. NEFF
The Neff Engineering Co.,
Milwaukee, Wisconsin

Offers sales and application engineering on air and hydraulic equipment to the metal, rubber, plastic, and paper industries in Wisconsin.

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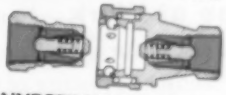
QUICK-CONNECTIVE FLUID LINE COUPLINGS

1. QUICK CONNECTION AND DISCONNECTION **2. INSTANT AUTOMATIC FLOW OR SHUT-OFF**

One-Way Shut-Off

Two-Way Shut-Off



ALSO STRAIGHT-THROUGH QUICK-CONNECTIVE COUPLINGS

Send for Catalog!

THE HANSEN MANUFACTURING COMPANY

4031 WEST 150th STREET • CLEVELAND 11, OHIO

Wire Rope at Work—Here's a load that required deft manipulation by three cranes working as a team. The absorption tower being guided into place was 98 ft long, 11 ft in diameter, and weighed more than 33 tons.

For the lifting and placing of this big, cumbersome load, the cranes were rigged with Bethlehem wire rope, Purple Strand grade, in the 6 x 25 construction; sizes, ⅞-in. and ¾-in. A typical assignment for Bethlehem rope, which so capably handles the toughest lifting and hauling jobs in every kind of industry.

Bethlehem Steel Company, Bethlehem, Pa. On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

Mill depots and distributors from coast to coast stock Bethlehem rope for the following industries and numerous others:

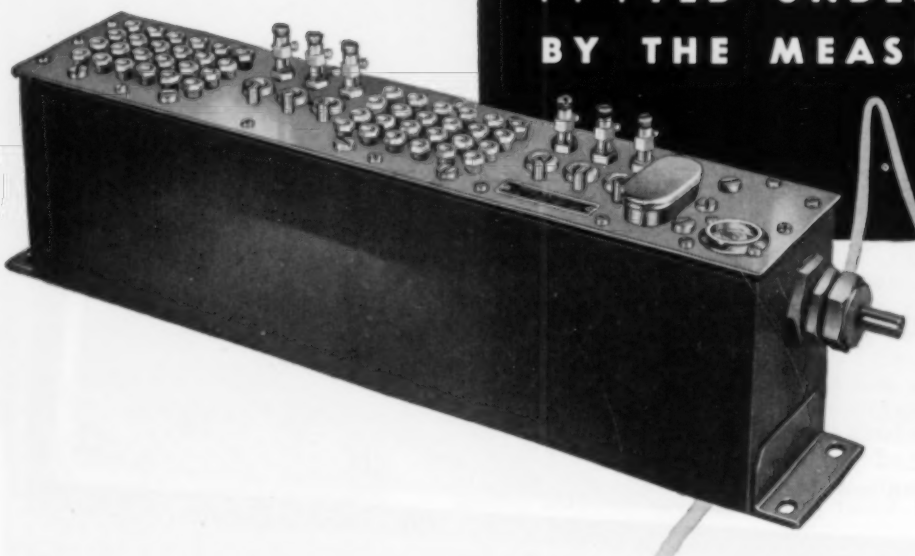
MINING • CONSTRUCTION • PETROLEUM • EXCAVATING • QUARRYING • LOGGING • MANUFACTURING

BETHLEHEM STEEL

BETHLEHEM WIRE ROPE

MADISON-KIPP *Fresh Oil*

. . . FED UNDER PRESSURE BY THE MEASURED DROP



the most dependable method of lubrication ever developed!

This lubricator becomes an integral part of a machine tool in which there are 48 vital bearings that require dependable lubrication. The Madison-Kipp mechanism is so compact that the reservoir measurements are only 4" wide, 19¾" long by 5¾ high."

There are six different models to meet almost every application requirement. Please write us for all details regarding your particular lubricator requirements.

MADISON-KIPP CORPORATION
202 WAUBESA STREET • MADISON 10, WISCONSIN

kipp

• Skilled in Die Casting Mechanics • Experienced in Lubrication Engineering • Originators of Really High Speed Air Tools

← Circle 7A on reply card
Circle 8A on reply card

GM DIESEL
CASE HISTORY NO. 5312-118

USER: Macco Corporation, Paramount, California.

INSTALLATION: GM Diesel-powered Ingersoll-Rand and Chicago Pneumatic rotary compressors supply air for Guniting riverbanks and earthquake-damaged building walls.

PERFORMANCE: Macco has standardized on GM Diesel-powered rotary compressors. Charles D. Dutro, Superintendent of Guniting Construction, reports steadier air, more positive pressure, gets 25% more work done than with other compressors. No repairs since units were installed more than a year ago.

It pays to STANDARDIZE on

. . . available in more than 750 models of equipment built by over 150 manufacturers

GM
GENERAL MOTORS
DIESEL POWER

"25% more work done"

with GM Diesel-powered Rotary Compressors

25% more work done per shift—steadier, more positive pressure—high portability—these are some of the reasons why Macco Corporation has standardized on General Motors Diesel-powered rotary compressors for their Guniting work. They report smoother operation and faster, easier moves.

Quick-acting GM 2-cycle Diesels pack more power in less space, so for building jobs Macco mounts the compressors on light trucks for faster trips. In intermittent compressor operation—and in every other kind of work—precision unit fuel injectors keep fuel consumption down. Contractors tell us that GM Diesels run for years without overhaul, but when parts and service *are* needed they are always quickly available.

More and more contractors are standardizing on modern rotary compressors designed around quick-accelerating GM 2-cycle Diesel engines. For more details on GM Diesel-powered compressors for your job, call your nearest distributor or write:

DETROIT DIESEL ENGINE DIVISION
GENERAL MOTORS • DETROIT 28, MICHIGAN
Single Engines... 16 to 275 H.P. Multiple Units... Up to 840 H.P.

ADV. 10

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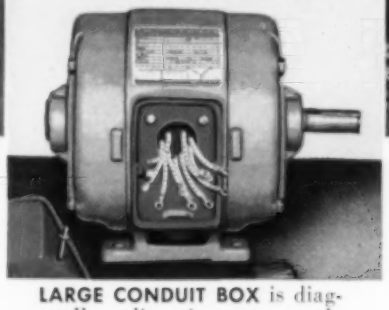
Circle 10A on reply card

TRI 55 CLAD THE LEADER IN MODERN MOTOR DESIGN

PERMA-NUMBERED LEADS

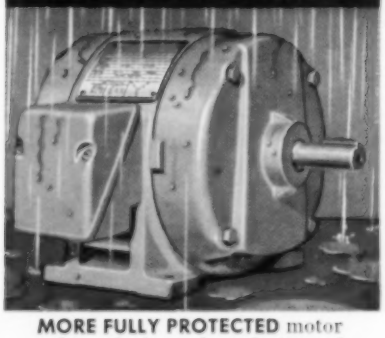
EASIER TO SERVICE, clipped or taped terminals always can be read. You save hooking-up time.

EASY ACCESS CONDUIT BOX



LARGE CONDUIT BOX is diagonally split—gives you ample knuckle room for easier wiring.

60% MORE PROTECTION



MORE FULLY PROTECTED motor achieved through redesign of cast iron frame and end shields.

LONGER MOTOR LIFE

NEW BEARING SYSTEM means the G-E motor runs longer without relubrication than any other.

Now, easier installation, less maintenance . . .

G.E.'s new TRI 55 CLAD motor— you can install it and forget it!

REG. U.S. PAT. OFF.

The all-new General Electric Tri/Clad '55' motor is specially engineered to reduce your installation costs . . . and run longer, without attention, than ordinary motors. This new motor gives you 60% more physical protection plus longer electrical life. In addition, a bearing system designed to use the most modern greases means you will not have to regrease the Tri/Clad '55' for years.

You save with the new Tri/Clad '55' because wiring is easier and faster. The large, diagonally split conduit box gives you plenty of knuckle room. Leads are perma-numbered . . . you can always identify them instantly.

The new Tri/Clad '55' also brings you important handling, storing and installing economies. Better use of space within the frame means a 30% reduction in size and weight in some ratings. Yet active materials (magnetic steel and copper) are not sacrificed.

General Electric Tri/Clad '55' motors are now available in many ratings. The complete line of 1 to 30 hp a-c motors will be available soon. For full details contact your G-E Apparatus Sales Office or G-E Motor Supplier today. Write for Tri/Clad '55' bulletins GEA-6013—Dripproof motors, GEA-6012—Enclosed motors, GEA-6027—Gear-motors. General Electric Company, Section 648-7, Schenectady 5, N. Y.

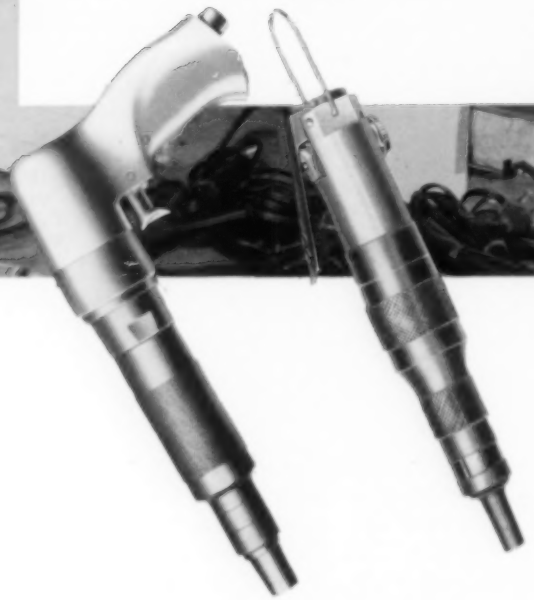
Progress is our most important product

GENERAL ELECTRIC

AIR engineering *provides the production pay-off!*

Ingersoll-Rand
Air-Powered
SCREW DRIVERS
pay off their cost in days!

Screws are driven quickly and uniformly on clock assembly line with Size 000BLC Screw Driver



I-R Air-Powered Screw Drivers

- provide torque control
- save assembly time
- reduce spoilage
- eliminate operator fatigue

Here's one example. An electric clock manufacturer installed 3 Ingersoll-Rand Air-Powered Screw Drivers to fasten clocks to their cases. Production stepped up immediately on this operation. The three tools—costing $315.—paid for themselves in 24 days!

You'll never know how speedy and effortless fastening operations can be until you've tried these Ingersoll-Rand Screw Drivers. Let an I-R Air Engineer show how you can apply these same cost savings to your own operations. Ask him for specifications and full details on our complete line of straight or angle Screw Drivers.

Or—try them in your own plant. We'll arrange a demonstration without any obligation to you, if you will write Ingersoll-Rand, 11 Broadway, New York 4, N. Y.

Ingersoll-Rand

8-26 11 Broadway, New York 4, N. Y.

See how AIR engineering *enables you to fasten it faster.*

Visit Booth 1835 at the ASTE exposition, Philadelphia, Pa., April 26-30.

they're using CRUCIBLE HOLLOW DRILL RODS on the New York State Throughway

This new high-speed superhighway will, when completed, speed streams of traffic across New York State from New York City to Buffalo.

It's a big, difficult construction job on which thousands of tons of rock must be moved. That's why you will find Crucible Hollow Drill Rods in use all along the route. Experienced construction men know they can rely upon the performance of these rods under the toughest field conditions.

There is a good reason for the dependability of Crucible Hollow Drill Rods . . . they are made to *tool steel* standards, by the leading producer of tool and special purpose steels. And this *extra* quality means fewer broken rods and lost bits. *For lowest cost per foot of hole drilled* — specify Crucible Hollow Drill Rods.

CRUCIBLE first name in special purpose steels

54 years of Fine steelmaking

HOLLOW DRILL ROD

CRUCIBLE STEEL COMPANY OF AMERICA, GENERAL SALES OFFICES, OLIVER BUILDING, PITTSBURGH, PA.

REX HIGH SPEED · TOOL · REZISTAL STAINLESS · MAX-EL · ALLOY · SPECIAL PURPOSE STEELS

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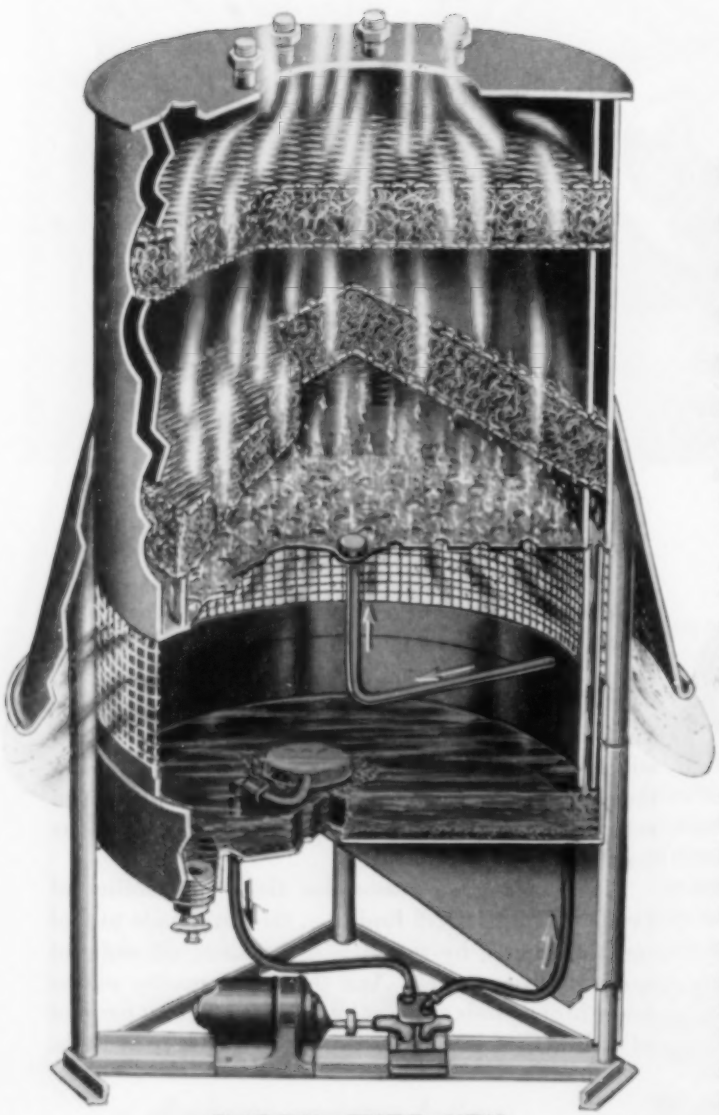
Circle 12A on reply card

THE NEW Cycoil OIL BATH



CYCOIL TYPE "P"

The only high efficiency oil bath air cleaner that meets the lower allowable intake resistance demanded with use of turbo-chargers and pressure blowers for scavenging.

Progress always creates new problems. With modern engines making wider use of turbo-chargers and pressure blowers for scavenging, the need for an entirely new and different oil bath air cleaner was apparent. Lower allowable intake resistance was a "must" accompanied by high cleaning efficiency and large dust holding capacity. Here was a new job for Cycoil—and AAF engineers accepted the challenge. The new Cycoil, Types "P" and "PV", is their answer.

A New Method of Oil Entrainment

The original Type "W" Cycoil impinged the air upon the oil at high velocity. The new Cycoil Type "P" accomplishes this entrainment by means of a perforated plate in the air stream over which oil flows from the central distributing head.

Here's how it works. The metered orifices in the plate are calibrated to increase the velocity of air flow through the openings to entrain the oil that tends to spill over the edges and at the same time distribute the air flow uniformly over the filter area.

The air leaving the perforated plate with its oil and dust content passes upward into a conical shaped filter designed to accelerate the flow of the collected oil droplets to the perimeter of the filter out of the air

American Air Filter

COMPANY, INC.

402 Central Avenue, Louisville 8, Kentucky • American Air Filter of Canada, Ltd., Montreal, P. Q.

MODERN ENGINE DESIGN DEMANDS IT!

AAF RESEARCH SUPPLIES IT!

LOW RESISTANCE TYPE AIR CLEANER

stream. This washing action keeps the filter clean and the dirty oil flows back to the reservoir where dust and grit settle out as sludge. A secondary filter is provided to remove any oil mist that might escape the conical filter.

The oil reservoir, at bottom, is hinged to swing clear of the Cycoil casing for easy sludge removal and oil replacement. A small motor driven oil circulator supplies a constant flow of oil over the orifice plate.

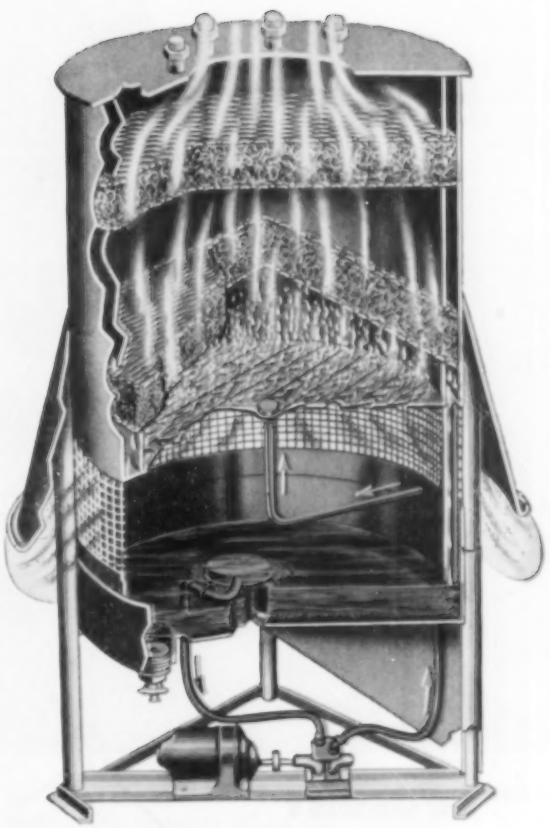
Two Types Permit High Efficiency Dust Removal From 10% of Rating To Full Capacity

The Cycoil Type "P" with standard metered orifices maintains a high efficiency in dust removal from *50% of rated capacity to maximum rating.*

The Cycoil Type "PV" is identical to the Type "P" except that hinged Vari-flow valves are added to maintain a constant ratio of orifice openings to air velocity. This single addition permits positive oil entrainment and sustained high cleaning efficiency *from as low as 10% of rating to full capacity.*

For the Hot Climates— Cycoil With Evaporative Cooler!

The Cycoil Type "P" is also available with an evaporative cooler using the perforated-plate principle to evaporate the water. This self-contained, combination unit features two perforated plates and filters in series, one flooded with water to cool the air and the other flooded with oil to remove the dust. Still another arrangement is applicable to engines using aftercoolers.



CYCOIL TYPE "PV" with Vari-flow valves

AAF

MAIL THIS COUPON, NOW!

American Air Filter Co.
402 Central Ave., Louisville 8, Ky.

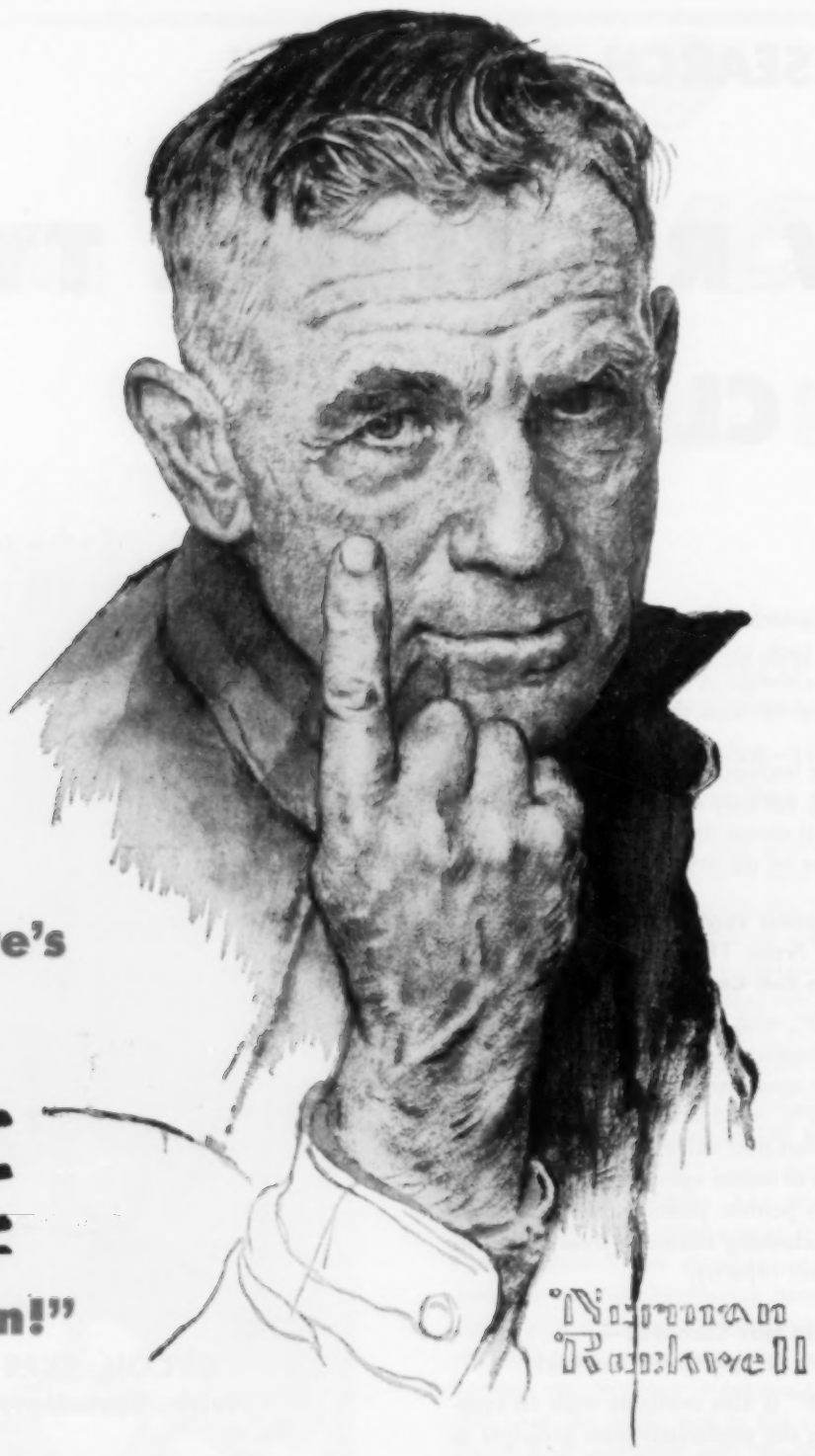
Send me free copy of Bulletin No. 160 describing the new Cycoil Low Resistance Oil Bath Air Cleaner.

Name_____

Company_____

Street_____

City_____ State_____



IT'S JUST THAT SIMPLE. There's only one reason in the world why so many wire rope users in the excavating and construction field prefer Roebling wire rope . . . *it costs a lot less on the job than any other.*

For maximum wire rope efficiency and economy, call your nearest Roebling office for a Field Man. He'll recommend the best ropes for your machines.

ROEBLING CF&I
A subsidiary of The Colorado Fuel and Iron Corporation

JOHN A. ROEBLING'S SONS CORPORATION, TRENTON 2, N. J. BRANCHES: ATLANTA, 934 AVON AVE. • BOSTON, 51 SLEEPER ST. • CHICAGO, 5525 W. ROOSEVELT RD. • CINCINNATI, 3253 FREDONIA AVE. • CLEVELAND, 13225 LAKEWOOD HEIGHTS BLVD. • DENVER, 4801 JACKSON ST. • DETROIT, 915 FISHER BLDG. • HOUSTON, 6216 NAVIGATION BLVD. • LOS ANGELES, 5340 E. HARBOR ST. • NEW YORK, 19 RECTOR ST. • ODESSA, TEXAS, 1920 E. 2ND ST. • PHILADELPHIA, 230 VINE ST. • SAN FRANCISCO, 1740 17TH ST. • SEATTLE, 900 1ST AVE. S. • TULSA, 321 N. CHEYENNE ST. • EXPORT SALES OFFICE, TRENTON 2, N. J.

ADV. 16

← *Circle 13A on reply card*

Circle 14A on reply card

COMPRESSED AIR MAGAZINE

How To Get The Most Out Of Compressed Air Systems

A. Milnes

Sarco Company, Inc.

The replacement of hand controls by Sarco automatic cooling controls on this 2-stage Ingersoll-Rand compressor resulted in better lubrication, less condensate in air, and a considerable saving in cooling water.

THE practical place to measure the capacity of your compressed air system is where it counts the most—at your compressed air tools. From the time air is first drawn into the cylinder, many things can happen which will effectively reduce air pressure and limit compressor capacity. Following is a concise explanation of the major causes of reduced compressor capacity and the steps which can be taken to remedy them.

PROPER AIR INTAKE

Your compressor system can be fouled up before a pound of air has been compressed if the air intake has been improperly located. The air intake should be located where the atmosphere is clean, cool, free from corrosive chemical fumes, and dry to minimize condensation in the system.

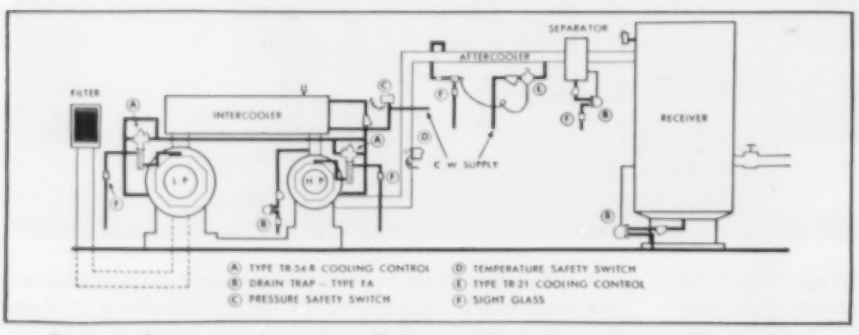
INTAKE PIPE DESIGN

A compressor can only operate at rated capacity if its air supply is unimpeded. Twisting, undersized pipes and dirty filters can effectively reduce air pressure at the compressor inlet. For example, a pressure loss of 2 psi due to friction in the intake pipe and filter will reduce the output of a 125 psi compressor by 7.5%. Check intake pipes and make sure they are short, of adequate size, and free of sharp bends.

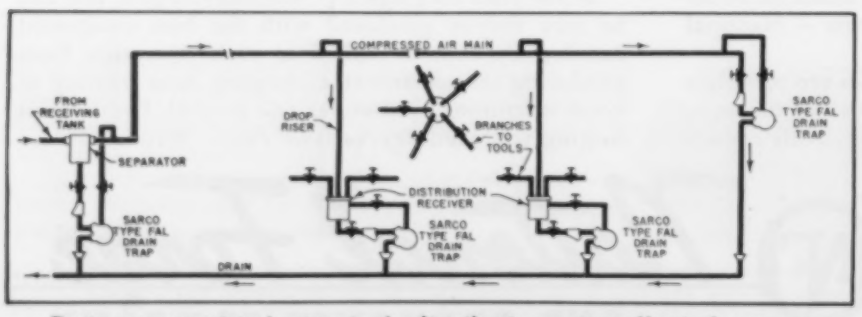
AUTOMATIC COOLING CONTROL

One of the major causes of inefficient compressed air operation is unbalanced cooling. For example, overcooling wastes water, causes deterioration of compressor lubricant by condensation in cylinder head. On the other hand, undercooling reduces compressor capacity, may result in serious damage to cylinders, pistons, valves and seats.

To offset this, many compressor manufacturers such as Schramm, Ingersoll-Rand, and others install Sarco automatic cooling controls at the factory. These controls are self-modulating, insure optimum cooling effect with minimum water consumption regardless of load variation, changes in pressure and temperature of water supply.



Sarco cooling controls are installed to regulate the water supply to cylinder jackets so that jacket discharge temperature is between 100-115° F.



Drain traps at critical points in the distribution system effectively remove condensate—protect compressor equipment, tools, and work.

CONDENSATE REMOVAL

If condensation is not kept to a minimum serious damage can result to tools, paint surfaces, molds, etc. Other results of excessive condensation in the system are water hammer and freezing of mains, receivers and tool exhausts.

To prevent this, well-designed compressed air systems usually have Sarco drain traps installed at the aftercooler, on separators, at receivers, and on low points in the lines to remove water as quickly as it collects.

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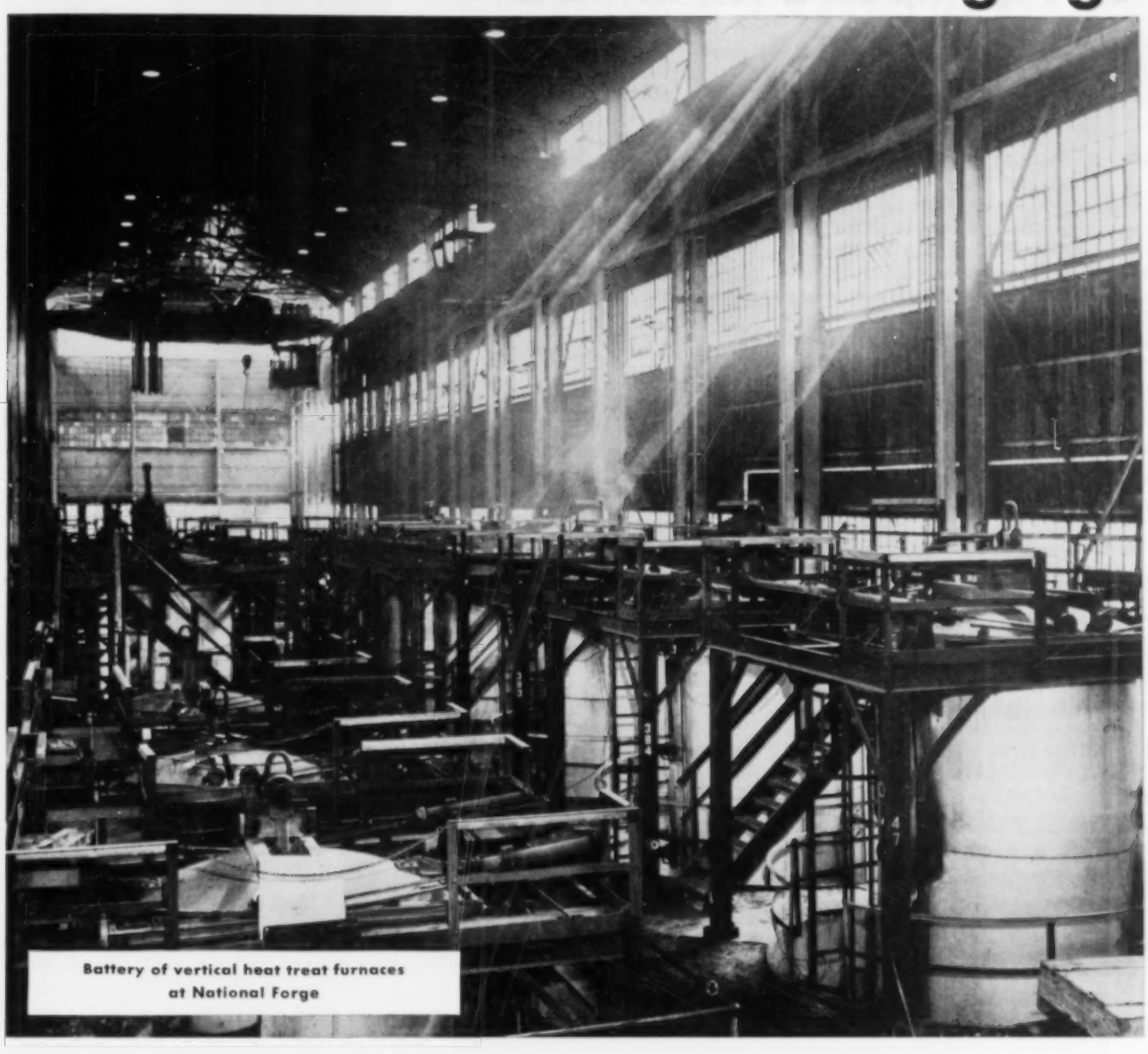

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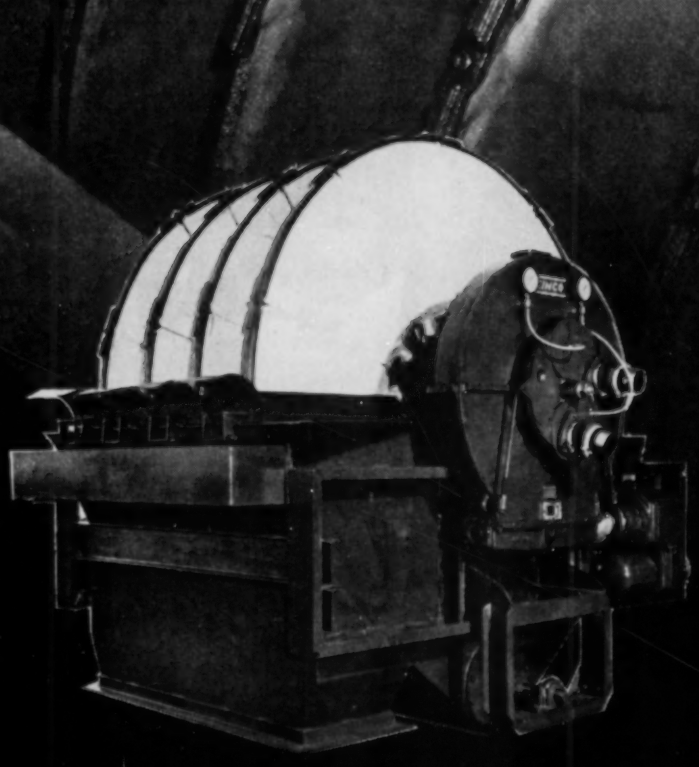
INCREASE PRODUCTION and LOWER MOISTURE CONTENT

in dewatering metallurgical slurries with fast settling solids



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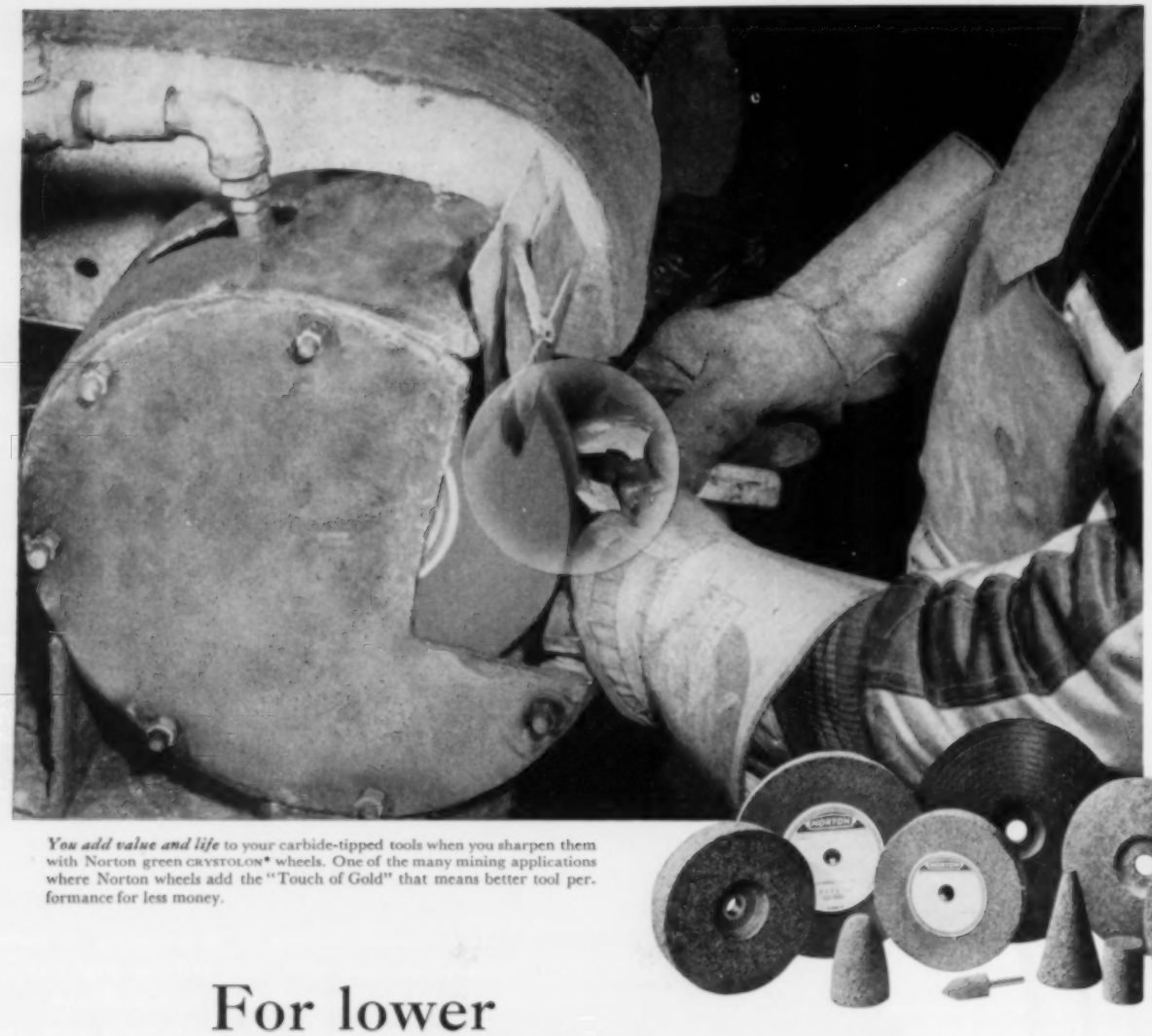

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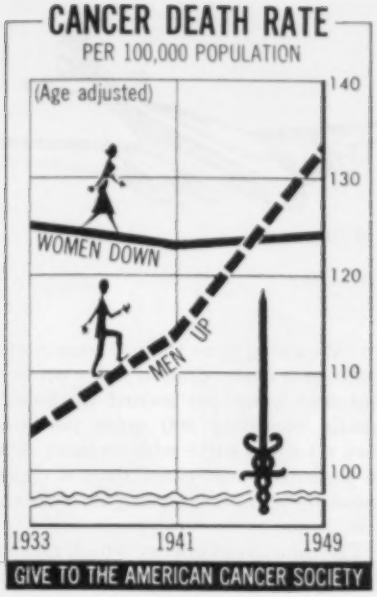

ON THE COVER

TO TRANSPORT the 2½ million tons of sand and gravel needed to mix concrete for Warragamba Dam (see page 96), a 12½-mile, $1,250,000 cableway was erected across the mountains to a 100-acre island in the bed of the Nepean River. There, stream-deposited material is dredged up by draglines, trucked to a plant that washes and sizes it and then loads it mechanically into the aerial carriers. At the dam-site terminal, one of the system's 550 buckets delivers, on an average, a 2700-pound load every 29.1 seconds.

IN THIS ISSUE

AIR, at one pressure or another, is all things to airplanes. As atmosphere, it provides a fluid for them to glide around in. When compressed, it performs various services, including that of setting them gently down for happy landings. Page 92.

•

EIGHT years of drought compelled Sydney, Australia, to take emergency measures to supply its residents with water and also hastened the beginning of work on a $50 million storage dam on the Warragamba River that will solve the problem for years to come. Slated for completion in 1957, it will be the largest structure of its kind on the continent. Page 96.

•

A GOOD indication of the magnitude of heavy rock work involved in carving out the route of the New York State Thruway is found in the fact that eight of the giant self-contained large hole-drilling machines called Quarrymasters are being used by various contractors to put in blastholes. Our second progress report on this 427-mile toll road starts on page 99.

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TOO many of us know too little about trees. A pleasant way of correcting the shortcoming is to visit an arboretum. Such a living display need not cost a fortune. An article starting on page 104 outlines how one New Jersey town is going about getting one

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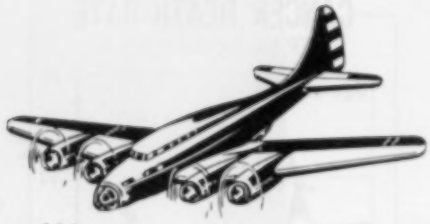
LANDING ON COMPRESSED AIR



When a plane comes down, its impact with the ground is cushioned by pumped-up oleo struts that evolved from the mechanism used to absorb the recoil force of big guns

ROBERT J. NEMMERS

IT WAS but 50 years ago last December that the Wright brothers coaxed a powered craft into the air for man's most historic flight.* Today, an airplane having a wing spread only inches less than the full length of that journey can roar across oceans and continents half way around the world before pausing. Others, not a great deal bigger than some of the earliest craft, but packing power plants of tremendous potential, flash through the skies faster than the speed of sound itself.

It would be misleading to single out any one particular design feature as being largely responsible for man's success in conquering the skies. It is readily apparent that each and every part plays a functional role in flying. However, there is one that has gone largely unheralded. That is the landing gear or undercarriage, and the reason it has gone more or less unnoticed is perhaps the fact that it is parasitic during actual flight. On that account, too, a great deal of time and effort has been spent in reducing its weight and streamlining or retracting it into the fuselage to reduce its air-drag effect. Yet the purely structural problem of supporting the plane while on the ground remains.

That many of the problems of undercarriage design have been solved is self-evident. Compressed air, because it is a convenient and lightweight means of storing energy, has been helpful in bringing this about. Modern-day aircraft, in the parlance of the flying fraternity, "sit down" on cushions of oil and air. Weighing more than 50 tons in some cases, and descending at rates up to 10 feet and more per second at forward speeds exceeding 200 miles per hour, they return to earth with no more shock to passengers and cargo than is experienced by a child bouncing on a feather bed.

The amount of energy which must be dissipated so that a plane will neither bounce back into the air nor any part be

*The distinction of actually being the first to fly in a powered craft belongs to Sir Hiram Maxim whose steam-engine driven plane "flew" in 1894. It was held within a few feet of the ground by limiting rails, however, and later crashed because of the failure of those rails to hold the craft down. Nevertheless, it was a powered plane and it did fly for a considerable distance about 2 feet above the ground supported only by air. Moreover, it carried three men—Sir Hiram and two engine operators.

OLD AND NEW IN TRICYCLE LANDING GEAR

An early Curtiss pusher-type biplane and the modern Navy Banshee fighter are compared below. The Curtiss, designed and built by aviation pioneer Glenn Curtiss, flew 50 miles an hour and landed on a tricycle-type gear that had no provision except its pneumatic tires for absorbing shock. The skid extending from the foremost wheel to the axle of the wing-mounted wheels helped the craft to negotiate ditches and surface irregularities as it came to a stop on rough ground. The Banshee, constructed by McDonnell Aircraft for carrier service and powered by Westinghouse turbojet engines, can cover 600 miles an hour.

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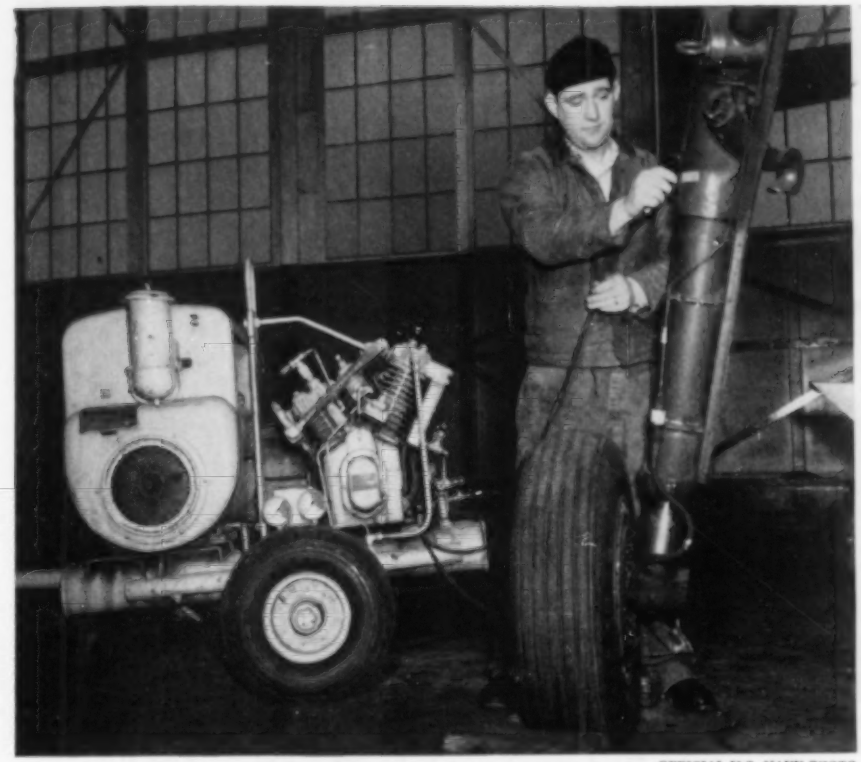

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PUMPING UP A PLANE'S "FOOT"

Servicing the oleopneumatic strut on a Navy Grumman Guardian plane at the Willow Grove (Pa.) U.S. Naval Air Station. The Ingersoll-Rand compressor is driven by a gasoline engine and delivers air to the "leg" through Aeroquip hose at pressures up to 3000 psi. Provision is also made for taking off air at 250 psi for tire inflation. Compressors of this type were shipped dismantled during World War II in containers no larger than aerial torpedoes and could thus be flown to forward air bases of the armed services and put in operation quickly. Another use for these units is charging torpedoes with high-pressure air.

unduly stressed is enormous. Too, engineers who design landing gear are confronted with two extremes—good and bad alighting. It is possible to fly an airplane onto the ground by means of a transition curve, which makes it unnecessary for the shock-absorbing units to function. That is good, and is generally intended but seldom achieved. It is also feasible to "drop" in such a way that the wheels need not roll. That, needless to say, is bad. Even though virtually all landings are closer to the first than the latter extreme, it is still necessary to make provision for the worst possible condition.

The device which has been most successful in meeting the safety and weight requirements of this service is the oleopneumatic strut—in essence, a hydraulic cylinder partially charged with compressed air. The hydraulic fluid or oil is transferred from one end of the cylinder to the other through orifices located in the piston or in an intermediate, fixed head. One transfer is made with each shock, and the return with each resultant reaction to the shock.

Consider the case of struts which have the cylinders anchored to the airplane and the pistons, with orifices in the heads, carrying the wheels. In the prelanding position each piston is at rest at or near the bottom of the cylinder, the hydraulic fluid is above it and air at a given pressure is in the remaining space. When the wheels hit the landing strip, the pistons are driven upward in the cylinders, further pressurizing the air and forcing oil through the orifices into the lower part of each cylinder. Then the air begins to reëxtend the strut. As the piston returns to its prelanding position, the displaced hydraulic fluid is transferred to the upper end of the cylinder. It is these transfers that cause the shock-damping reaction by dissipating in heat and friction the energy imparted to the oil. The orifices are specially designed to restrict its passage to pressure levels commensurate with the weight of the craft and the amount of energy which must be dissipated. The quantity of oil and air, the pressure of the air during static and dynamic loading, the stroke and cross-sectional area of the piston are likewise dependent on the weight of the plane and on operational conditions.

Generally speaking, military aircraft are equipped with heavier-duty struts than civil planes because they carry bigger "pay loads" under more rigorous conditions. Too, they must at times land on and take off from runways that are at best hurriedly built and sometimes inadequately maintained. Carrier-based naval aircraft are subjected to what may well be the most strenuous landing operation of all. The upward pitch of the deck and the vertical descent of the plane may combine to give effective landing velocities of more than 20 feet per second.

The evolution of undercarriages is a fascinating study in applied engineering—in cut-and-try methods or what may be termed "gadgeteering." The first Wright machine took off from a monorail launching carriage and landed on skids. Later planes were equipped with crude wheeled undercarriages that not only looked like but were afterthoughts. Many of them had no means at all of absorbing the shock of landing. Others relied on heavy-duty rubber bands for springing (one of these is illustrated).

Most of the undercarriages of that day had at least one thing in common—a skid or skids which projected skilike toward the front of the airplane. Two things made that type virtually mandatory. The first was the shortage of adequate landing fields, and the second was the unreliability of aircraft engines. If, as often happened, the motor "conked" out, the plane had to come down in the nearest open field, which frequently was studded with natural hazards such as ditches and stumps. The skids enabled the light planes of the day to negotiate those obstacles without much damage to craft or pilot.

It is significant to note that nearly all the early wheeled machines (with or without ditch-running skids) had the tricycle-type landing gear common on our most advanced craft today. Airplanes of the World War I period and up to the last conflict had, for the most part, a tail skid or small wheel. United States designers were the first to recognize certain superiorities of the tricycle gear, and shortly after the beginning of World War II some American craft were so equipped. Its advantages lie largely in the landing and take-off stability it gives the plane.

It is a tribute to the genius of the early designers of aircraft that they conceived and tried, insofar as they were able, nearly every major advance made since then in construction, from swept-back wings, retractable landing gear and rocket or jet engines to the oleopneumatic strut. The last-named device first appeared on an airplane around 1909. It was not new even then, however. Makers of heavy pieces of field artillery had long used a more simple form of recoil absorber. In view of this it is not surprising that one of the earliest (1915) patents on this type of aircraft shock absorber was issued to the well-known British gun manufacturer, Vickers-Armstrong, Ltd.

The oleopneumatic strut was not generally adopted, however, until the mid 1930's. It is of interest to trace the

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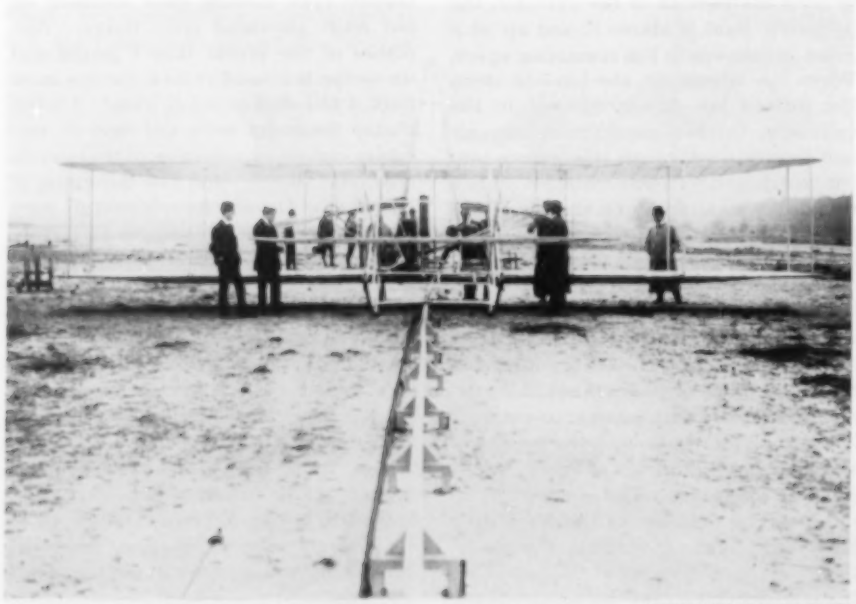
NAVY R6V CONSTITUTION

This Lockheed-built craft seems to have more than its share of wheels—four on each wing strut in a dual tandem arrangement and two on the nose wheel strut add up to ten. The 4-engined giant bird is 156 feet long and 189 feet across the wings. The bogies are suspended from air-oil struts for shock absorption.

high points of undercarriage evolution up to that time and note the conditions that led to many of the modern innovations in landing-gear design. During the period immediately preceding the first world-wide conflict, military men began to grasp the potential war-making capabilities of the airplane and to press for its continued development. That was accompanied by the production of powerful engines with low weight-horsepower ratios, thus making it possible to send aloft well-nigh any flying machine no matter how badly or inadequately conceived—a process that promoted aircraft design by providing voluminous data previously not known. Those engines were much more dependable than the early power plants, and before long skids were dropped from landing gear as an unnecessary weight.



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EARLY RECORD BREAKER

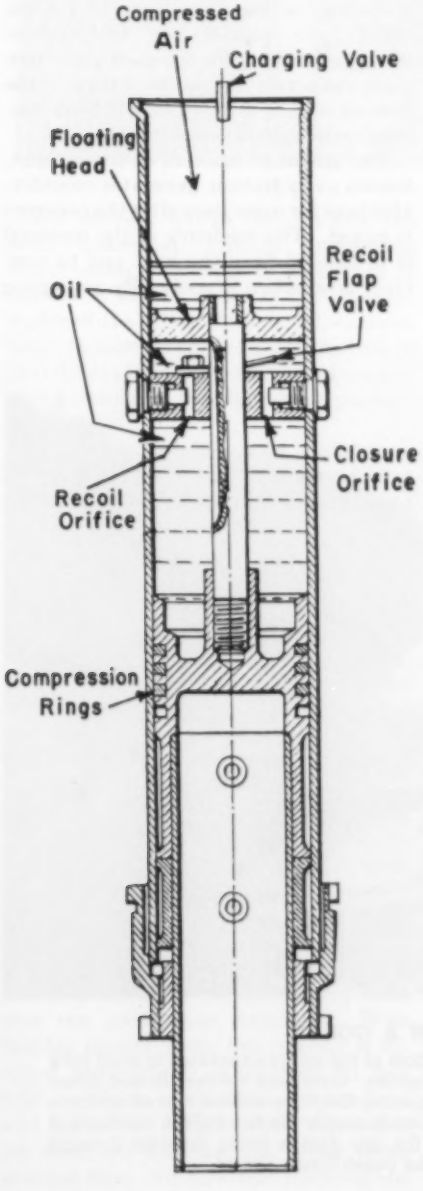
Shown here is the Wright airplane as it was being readied for launching at LeMans, France, September 21, 1908. Wilbur Wright flew it at a speed of about 37 miles an hour, covering 56 miles in 1 hour, 31 minutes and 25 4/5 seconds, establishing new records for distance and duration of flight. The skid-mounted, rail-launched craft was powered by a 4-cylinder 24-hp engine that ran at 1200 rpm and drove two wooden propellers at 450 rpm through chain gearing. The weight of the motor was reputedly 200 pounds, that of the entire plane about 1100 pounds, and the wing span was around 41 feet. Little provision was made for absorbing the shock of landing on the skids.

Soon undercarriages assumed the form they were to keep for nearly fifteen years —two vee-shaped struts with the axle carried at the apexes of the vee sections. Tail wheels were first used, next tail skids, and then wheels again. With the return swing of the pendulum came shock absorbers for the tail wheel. With this last improvement, development, no longer spurred on by military requirements, slowed down. Undercarriages remained pretty much as they were at the close of the war, their most outstanding characteristics being the vee-shape, shock absorption by steel springs or rubber bands and a tail wheel or skid.

Then the arms race preceding World War II started with Nazi Germany in the early 1930's and spread throughout the globe. Sleek, deadly fighter and bomber planes appeared with but one wing low on the fuselage in contrast to biplanes and the early monoplanes with airfoils mounted above the fuselage. The matter of speed became all important, and landing gear was streamlined and then designed to be retracted into the wings or fuselage to cut air drag. With

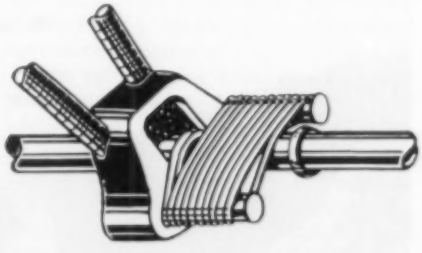
those developments came increasing interest in the oleopneumatic strut, and many designers brought out new and different types. The first ones used air at relatively low pressure, the strut being reëxtended chiefly by springs or rubber bands.

As a logical consequence, it was discovered that the job could be done just as effectively and with less weight by means of high-pressure air. Research had provided materials and machining methods that permitted the struts to carry pressures in the neighborhood of 3000 psi for extended periods without leakage. Alloy steels increased the strength of parts without adding to their weight, and aluminum and its alloys began to play an important role in the same field. In most cases, modern undercarriages weigh less than 4 percent of the total in-flight weight of an airplane. This low weight ratio was equaled by only a few of the early landing devices. In the United States, the oleopneumatic strut and the principles of landing-gear retraction once again led to the use of the tricycle type. Today not only the very largest but also the smallest craft are so equipped. It should be pointed out that the design of undercarriages has undergone little standardization, a situation that has persisted since the earliest days of flying. As a matter of fact, there are as many different types as there are different services.



Throughout the previous discussion of air-oil struts we paid little attention to another part of landing gear—the pneumatic tire—which also depends on compressed air. It, too, has undergone great changes in the last half century in size, type and number. On many of the early planes no provision was made for shock absorption other than the tires. The outcome was the well-known balloon tire and other types such as the "puncture-proof" automotive tire (from the self-sealing aircraft tire) and the low-pressure and tubeless types. One of the more interesting problem solutions in connection with airplane tires is the use of small flaps cut into the casing to start the wheel turning before the plane hits the ground. Prior to that, with the faster landing speeds of the last fifteen years, a tire actually skidded for some distance before it finally started rolling. Needless to say, this caused excessive wear.

As aircraft grew bigger and bigger, tires grew in size, and many of the world's largest, exclusive of those on earth-moving equipment, were put on bombers. It was not the difficulty of making the huge tires that led to their abandonment, but simple economics of landing-strip construction. Unless thick and prohibitively expensive concrete runways were built, they could not stand the shock of such heavy loads and impacts concentrated on the limited area of contact of a single tire on a strut. This brought about the development of bogies —two or more tires mounted side by side and in tandem, an arrangement that is found on most of the world's bigger aircraft and is being used more and more on jet planes.



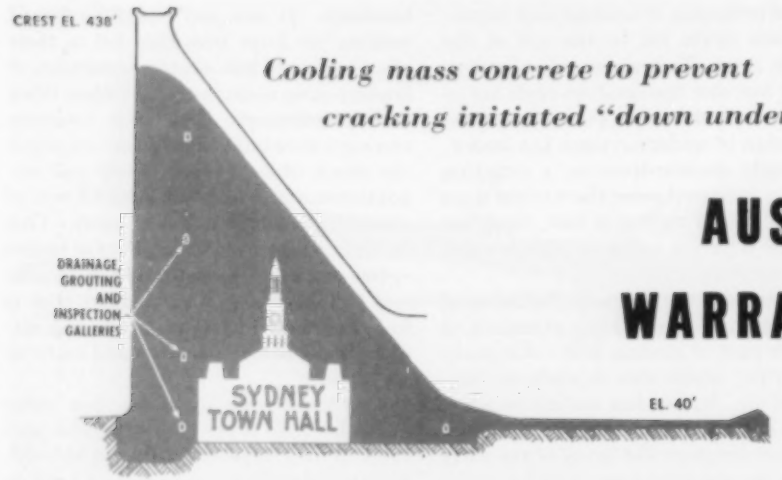
FORTY YEARS OF SHOCK ABSORBERS

An early (about 1915) rubber-band shock absorber (above) with the axle cradled by the rubber rings and riding in a simple horn block suspended at the apex of a vee-shaped strut. This device was "good enough" for the days when pilot, motor and air frame each often weighed about the same. Compare it with today's basic oleopneumatic strut (left)—part of an undercarriage that represents less than 4 percent of a plane's flying weight. The strut is shown in its extended or prelanding position. As the piston rises when the craft lands it forces oil through the closure orifice. Then the compressed air in the top chamber, acting on the floating head, forces the oil back through the recoil orifice. This re-extends the strut. Thus the energy of landing is "soaked up" by the oleo fluid. There are a great many variations of air-oil struts, each designed for a given set of service conditions.

The latter role of bogies has come about because of the thin wing-root sections of this type of craft and the difficulty of finding room to retract landing gear with large single wheels. It has also been determined that multiwheel construction actually lessens the weight of undercarriages and increases the loading and take-off stability to a degree. The German air arm attempted to solve this problem in the closing days of the last war when it conducted its famed experiments with rocket and jet-powered planes. It went back to the Wrights' idea of a launching rail and having the craft land on skids. According to some authorities, the idea may yet prove to have merits that will outweigh its disadvantages and might well be adopted in the future. The German skid had oleopneumatic struts to absorb shock and was retractable. It occupied only a small fraction of the space required for more conventional gear and was much lighter.

Servicing struts has called for the development of small high-pressure air compressors capable of being transported easily and of delivering up to 3000 psi. One of these, designated as the P33 10-G by its manufacturer, Ingersoll-Rand Company, is shown in an accompanying illustration in action at the Willow Grove (Pa.) U.S. Naval Air Station. The machine is also adapted for the inflation of aircraft tires, and for this purpose is supplied with a 250 psi take-off. It performs many other jobs that differ with the type of plane being serviced. Charging high-pressure cylinders known as dump tanks is one of the most common of these. The cylinders are a source of power in the event the hydraulic system fails to work and are used to lower and lock the landing gear in such an emergency. Fittings based on the A. Schrader's Son tire valve are standard throughout the U.S. Armed Forces. In fact, that company manufactures many of the fittings for oleopneumatic struts.

However odd the statement may sound, air—under pressure—is becoming increasingly important to aircraft. They fly through it, their cabins are pressurized with it, their emergency systems use it and, finally, they land "on" it.



Cooling mass concrete to prevent cracking initiated "down under" at

AUSTRALIA'S WARRAGAMBA DAM

A DAM that is now being constructed by the Sydney Water Board in the gorge of the Warragamba River about 50 miles west of Sydney will be the largest in Australia and possibly in the Southern Hemisphere. Planned to assure a constant supply of water for the domestic and industrial needs of that seaport and outlying areas at least until the beginning of the next century, the barrier will impound 460 billion gallons of water.

Located in the foothills of the Blue Mountains, Warragamba Gorge is ideally suited for a project of this kind because its well-nigh sheer sandstone walls are from 400 to 500 feet high for a distance of nearly 14 miles. The dam will back up the river for 35 miles in rough wooded country, creating a long narrow lake fed by a watershed slightly less than 3400 square miles in extent. Preliminary work was begun in 1946. By June of 1952 approximately 500,000 cubic yards had been excavated, and when pouring of concrete began last summer it was hoped to maintain a schedule of 2000 cubic yards a day.

The structure rests on sandstone strata in which weathering has opened vertical cracks and joints reaching to a general depth of 30 feet. Below that the rock is sound except for a few clay seams. To be sure of a firm foundation, the subsurface of the site was thoroughly investigated beforehand. In line with prevailing American practice, these operations included the sinking of holes large enough to permit lowering geologists to inspect the rock in place and to yield cores of adequate size for detailed study.

This probing was done with two Calyx core drills, an Ingersoll-Rand 48-inch unit and a 36-inch model built by the Sydney Water Board. The latter machine, however, was not put in service until near the end of the work. The 48-inch Calyx drilled fourteen holes totaling 2841 feet, the deepest one being 289 feet. Cores were carefully preserved for subsequent study and testing.

Grout was injected into the foundation area to consolidate the underlying material and to seal off flows of ground water that had been revealed by the Calyx shafts. This work included the placing of a cut-off "curtain" to a depth of 150 feet underneath the entire strip which is to be occupied later by the upstream face of the dam.

Of the straight gravity type, the dam will have a maximum height of 420 feet, will be 1100 feet long at the crest and contain 1,400,000 cubic yards of concrete. Floodwaters will be passed over a 300-foot-wide spillway by opening drum gates 40 feet high. The structure is being reared in a series of blocks or prisms measuring 50 to 60 feet on the sides. Each is built up 5 feet at a time, and pouring is not done in adjacent blocks simultaneously. By thus dividing the mass into a large number of individual monoliths separated by transverse and longitudinal joints it is possible to minimize the formation of cracks, which are caused by temperature changes resulting for the most part from chemical action during the setting of the cement and to a lesser extent from seasonal atmospheric variations.

The chemical reaction of the cement, known as hydration, generates considerable heat for some time after the concrete is mixed. The tendency of the material is to expand from the heat and to contract later when it cools. By providing

DAM SITE IN A GORGE

Upstream view showing the walls and bottom of the gorge excavated to solid rock in readiness for building a 420-foot-high barrier. Overhead are two 18- and 10-ton capacity cableways for transporting and placing the three million tons of concrete it will contain. The dam will impound water to supply the two million residents of Sydney and vicinity. The river behind the low dam is being diverted through the canyon walls by two tunnels during the construction period.

FOUNDATION EXPLORATION

As a part of the preliminary investigation of the dam site, two Calyx core drills put down large-diameter holes to permit examining the foundation rock in place and also to obtain cores big enough for detailed study. An Ingersoll-Rand machine that drilled a total of 2841 feet is shown at the left. Below are sections of a 48-inch core extracted from one of the holes.

SYDNEY WATER BOARD PHOTOS

joints between blocks the concrete can swell somewhat without undergoing compression. The rate of hydration of cement is slowed down if the concrete is placed at a relatively low temperature. This, in turn, reduces the generation of heat during the first few critical days and counteracts the tendency to produce cracks later.

To obtain this favorable initial temperature at Warragamba, cement with a low rate of heat generation is being used and most of the mixing water is being added in the form of ice. The remainder is chilled to 34°F. The maximum ice content of the mix is 132 pounds per cubic yard. Then, to keep the temperature low throughout the period of setting, chilled water is being circulated through a network of pipes, embedded in the mass every 5 feet vertically, for several months after the time of pouring. At each of these levels, ¾-inch steel tubing is laid 5 feet apart horizontally and connected by loops at the ends to form continuous coils. All told, 400 miles of piping will be used.

After the temperature of the concrete has been stabilized, cement grout is pumped under high pressure into the joints between the blocks to bond them into one continuous structure. With flexible copper seals, the interior is divided horizontally into zones 50 feet high. Within each zone, longitudinal and transverse joint systems are sealed off from one another, the latter being grouted first. To facilitate reaching the numerous points from which the circulation of the cooling water is controlled and the subsequent movement of grout pumps into the different sections, horizontal galleries are being built in the dam at vertical intervals of 50 feet and connected by shafts, some permanent and some temporary.

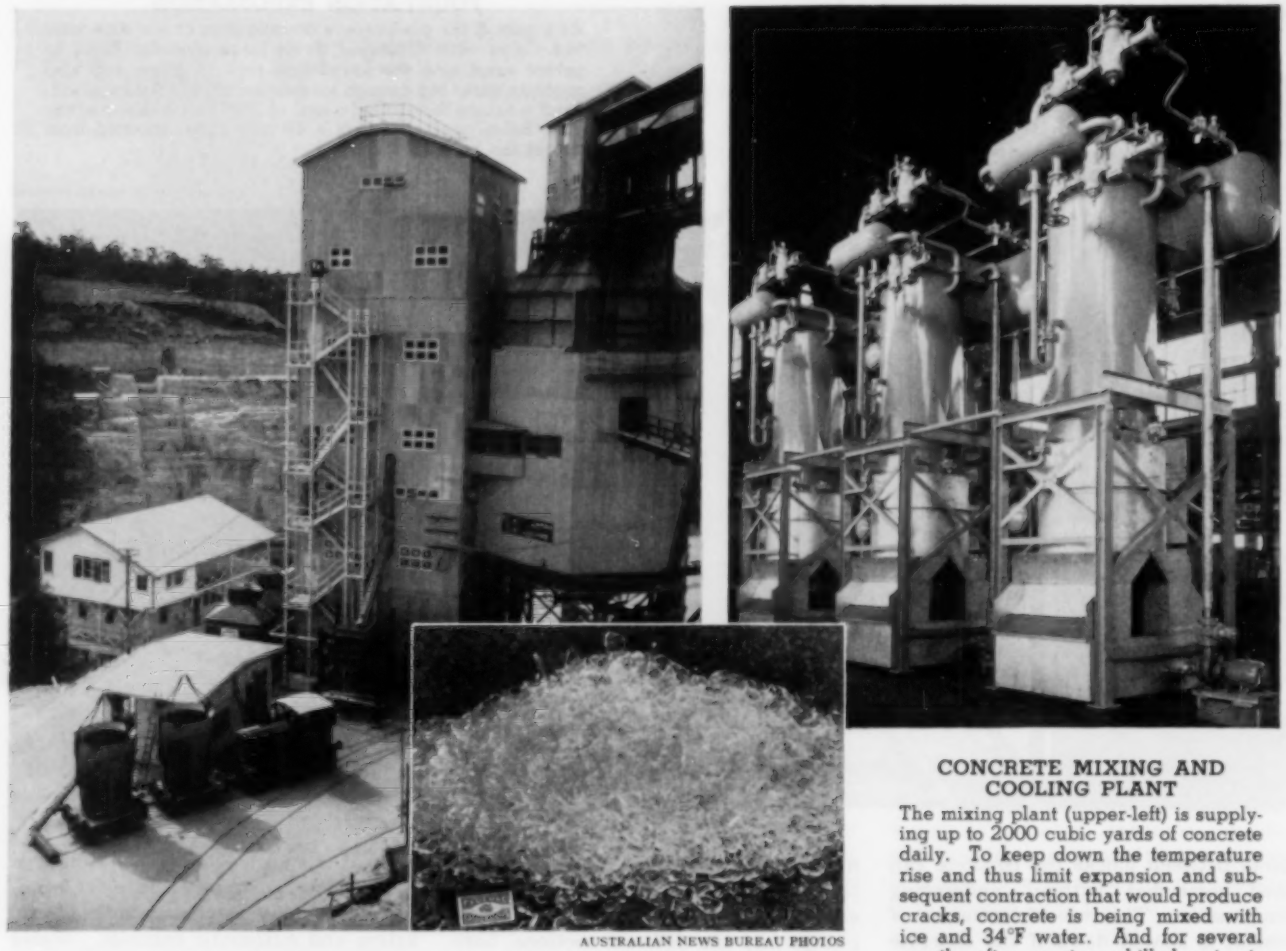
The refrigerating plant in use simultaneously produces 170 tons of ice and chills 10,000 gallons of water every day. It is readily adjustable to meet the daily concrete-pouring needs and manufactures ice that can be easily conveyed, weighed and fed into the mixers and broken up into pieces small enough to disintegrate within the 3-minute mixing cycle. The installation consists of three tube-ice machines built by Henry Vogt Machine Company, of Louisville, Ky., and set up at the site by J. Budge Pty. Ltd., which also furnished the remainder of the plant.

From 1940 to 1952, electric power output increased 180 percent in the United States, 106 percent in Canada, 114 percent in France, 117 percent in the United Kingdom and 150 percent in Soviet Russia.

The Vogt machines produce ice in the form of hollow tubes, ⅜ inch in shell thickness, which are crushed into segments about an inch long before being dropped into a 60-ton hopper-bottomed storage bin. Each unit is composed of a vertical cylindrical shell containing a nest of tubes, an ammonia transfer drum, cutter, ice chute, pumping tank, pump, valves and automatic controls. Water pumped from the lower tank to the top of the housing gravitates through distributors, which direct it against the inner surfaces of the tubes where ice forms through evaporation of liquid ammonia in the shell. Excess water returns to the tank and is recirculated.

All the operations are automatically controlled by adjustable timing mechanisms that start the water pump and admit ammonia into the shell by opening refrigerant and suction valves. At the end of the freezing period all the valves are closed and pressure is applied to the ammonia to return it to the transfer drum. The cycle is not repeated until the ice has thawed sufficiently to slide out of the tubes. As it drops into the storage bin beneath, it is reduced to the desired size by a motor-driven cutter. Normally, it is held there for not more than eight hours. It is fed by gravity on to a screw conveyor which carries it to the concrete mixing tower where it is automatically weighed and dumped into the mixers.

The ice-making plant and a 4500-gallon water cooler are housed in a 100-foot tower of unique construction. Because of a shortage of structural steel, the twelve 18x18-inch supporting beams of prestressed concrete were cast on the ground and hoisted into place. Ten of them are 75 feet 11 ½ inches long and the



AUSTRALIAN NEWS BUREAU PHOTOS

CONCRETE MIXING AND COOLING PLANT

The mixing plant (upper-left) is supplying up to 2000 cubic yards of concrete daily. To keep down the temperature rise and thus limit expansion and subsequent contraction that would produce cracks, concrete is being mixed with ice and 34°F water. And for several months after pouring, chilled water is circulated through the structure in a network of embedded pipes. Shown above are three Vogt American-built machines that produce ice in the form of thin-walled tubes that are broken up (bottom-center) before they are incorporated in the mix.

others 56 feet 4½ inches. At the base of this tower is the ammonia compressor and condenser installation. The former consists of five twin-cylinder, vertical 10-inch stroke units each driven by a 150-hp motor. Four of them serve the tube-ice machines and the fifth supplies refrigerant to a submerged coil in the water cooling tank. The latter meets the demands of both the ice-making units and the concrete mixers. It is estimated that the use of precooled water in the ice machines reduces their power consumption by approximately 30 bhp.

Compressed air is being utilized considerably in handling the cement for the dam. At the mill where it is manufactured, it is elevated by pneumatic conveyors into storage silos to age for at least a week. From the latter it is loaded into tanks of 3-ton capacity, two or more of which are mounted on a truck for hauling to the building site. There the material is dumped into a receiving hopper and thence moved to any one of three points.

During the overland trip, jolting because of road irregularities packs the cement firmly in the tanks and it has to be broken up before removal so that it will flow readily. This is accomplished by permanently fitting a length of canvas fire hose crosswise on the bottom of each container. One end is closed and in the other is inserted an air connection. The hose is deflated during the loading and transit period, but prior to unloading it is alternately inflated and deflated several times to loosen the compacted cement. This "arch-breaking" device was designed by the Board's engineering staff.

Upon arrival at the dam the trucks are weighed before and after discharging to keep an accurate record of the cement delivered. Most of it goes directly from the receiving hopper to either the main or the auxiliary concrete mixing plant. That which cannot be used immediately is stored in one of two 800-ton silos, and this reserve supply is drawn on whenever the concrete mixing rate exceeds the cement delivery rate.

Some sections of the pneumatic conveying system at both the mill and the dam are of the Air Slide type which consists of a duct, 6x6 inches in cross section, that is divided into an upper and a lower passageway by continuous porous webbing extending from wall to wall about 2 inches above the floor. Cement is carried in the upper part of the slide. When compressed air at about 2 psi pressure is introduced into the lower space, it percolates through the diaphragm, aerates the cement and causes it to flow along in a steady stream.

While plans call for the completion of the dam by 1957, engineers cannot foretell when the reservoir will be filled. Figures on that score vary from a few days to a number of years. Since the watershed is enormous, floods are not uncommon. The normally shallow river rose to a height of 100 feet during the record flood of 1952 when the flow through the gorge reached 225,000 cubic feet per second. At that rate the basin would have been filled in only five days, as against eight years in periods of drought. In anticipation of future power needs in the area, the structural part of a hydroelectric station will be provided, but generators will not be installed at present.

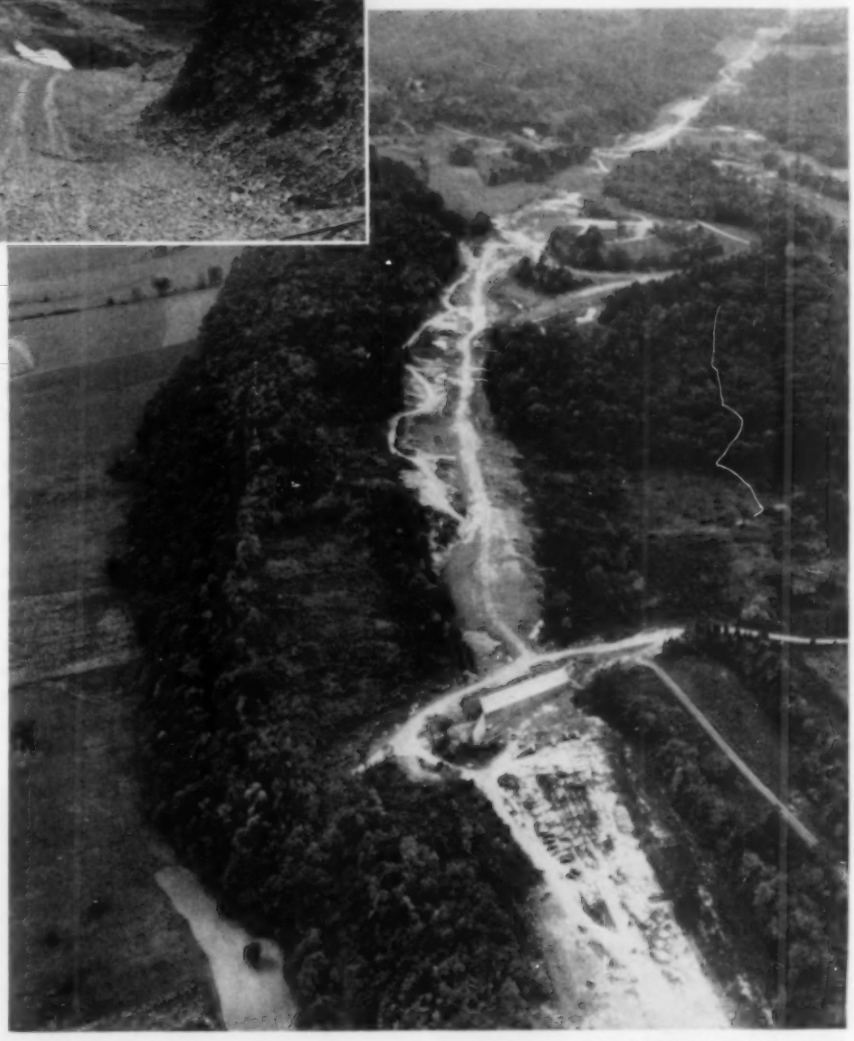
The total cost of the Warragamba Dam is estimated at $50 million. Of this amount about $200,000 is chargeable to the refrigeration plant. This is believed to be the first time that equipment of this kind has been of aid to concrete construction "down under," although ice and chilled water have been used successfully for that purpose on several large projects in the United States.

Progress Report No. 2

NEW YORK THRUWAY

Eight Quarrymaster Drills Help Contractors Attack Huge Volume of Rock

J. C. Pierce



FAIRCHILD AERIAL SURVEYS PHOTO

THROUGH WOODS AND HILLS

The aerial view, right, shows a stretch of Thruway being built by The Savin Construction Corporation along a ridge of low hills just west of the Hudson River and close to the town of Catskill. Above is a surface view in the same section. The cut in the foreground is in shattered shale. In the middle ground a bridge is under construction and beyond it a Quarrymaster drill is at work.

ASSEMBLE some 2400 engineering specialists to conceive and plan, half a hundred of the country's leading highway contractors to execute the plans, 18,000 skilled and unskilled workers to direct and operate about $100 million worth of modern construction equipment and raise half a billion dollars to foot the bills, and you would be ready to tackle the building of the 427-mile New York State Thruway on which we had an article in our January issue. For that matter, you would be prepared to dig another Panama Canal or Mesabi Range iron-ore pit or to rear a second Hoover Dam. Besides the brainpower and manpower directly engaged, you would also need upwards of 20,000 workers in scores of factories to supply a steady stream of materials and equipment.

As a further indication of the scope of the project, it should be mentioned that it requires the removal of approximately one-third as much of the earth's crust as was dug for the Panama Canal. Excavation is estimated at 80 million cubic yards and involves moving enough earth and rock to build a solid wall 6 feet high and more than 2½ feet thick around the earth at the equator. And that doesn't include the borrow rock and earth for fills, which accounts for another small mountain. The concrete in the finished expressway will exceed the 3,325,000 cubic yards placed in Hoover Dam or the aforementioned canal with its extensive lock system.

But you wouldn't start actual highway construction without a carefully plotted course and with many details of the road and its structures minutely designed. This calls for painstaking work on the part of the unsung heroes of projects of this kind—the geologists, soil specialists, lawyers, office engineers, draftsmen, designers and many other technicians whose efforts are rarely recognized by the ultimate user—the highway traveler.

Aerial and ground reconnaissance makes it possible to establish the most desirable route. Soil analyses and geological data show that no insurmountable natural obstacles will be encountered along the proposed course. Legal studies determine the availability of rights of way. Engineers and design experts make sure that requirements as to grade and structure will be met throughout the line. Only after these investigations have been completed can the survey

CONCRETE RIBBONS MEET THE HORIZON

A completed section of the Thruway about 40 miles south of Albany built by The Lane Construction Corporation and now open to limited traffic. The picture was taken from a bridge that carries a local road across the expressway.

crews drive their stakes, can bids be let for construction and the voluminous data start to flow out from headquarters. The blueprints for this undertaking, if placed end to end, would reach along the Thruway from Buffalo to Albany, a distance of more than 300 miles.

Every specialized type of modern earth-moving, bridge-building and paving equipment has been called into service by the contractors, who are faced with many and varied excavation and construction problems—some common and some unusual in highway work. It would take a large volume to tell the full story, so this article will deal only with some of the machinery on the job and with certain contracts and procedures not covered in our first installment.

Although earth represents the greater percentage of the material being moved, rock excavation probably accounts for the bulk of the expense and effort involved. Drilling equipment is therefore in the spotlight. It ranges in size from 36-ton Quarrymasters—eight pitted against the large, tough jobs—down through many makes and styles to handheld Jackhamers used to blockhole boulders and to provide initial footholds for heavier machines on the steeper virgin slopes. By far the greatest lineal footage of blastholes is bored by rugged, adaptable wagon drills—the "mountain sheep" or "work horses" of the road-building gangs. They often supplement or serve in lieu of the huge quarry-type units on big rock cuts, make precision line cuts and trim grades and banks, work in which they are called on to operate while clinging spiderlike to precarious slopes.

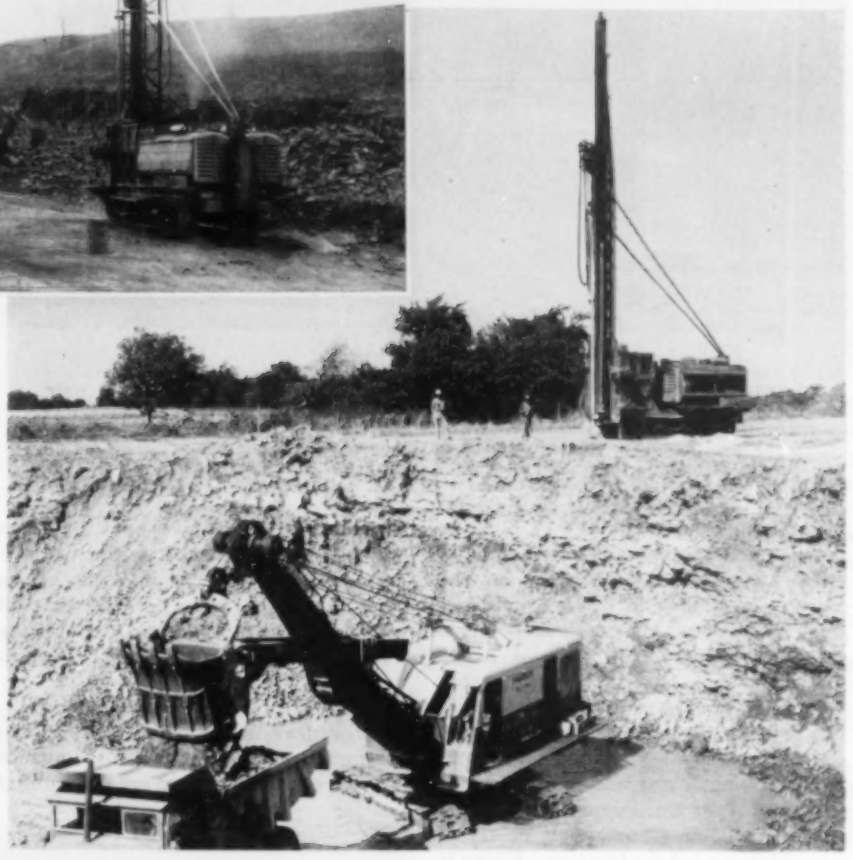
FIVE-YARD BITE

A large Bucyrus-Erie electric shovel loading rock blasted from a cut that is 50 feet high in some places. Six-inch blastholes were drilled to depths up to 55 feet at speeds as great as 18 feet per hour by a percussion-type Quarrymaster drill using Carset bits. The contractor was George M. Brewster & Son, Inc.

Since the spearhead of attack on rock is the drill bit, the Thruway is a large-scale bit testing ground. Today, a bit is manufactured to meet every conceivable drilling need, so the original procurement problem is generally negligible and attention is focused on means of sharpening bits after repeated dulling. Of prime importance to the contractor, then, are blacksmith shops adequately equipped and manned for efficient bit examination and reconditioning, drill-steel make-up and upkeep, tool sharpening and other tool maintenance operations. Incidentally, bits for either large or small boreholes that require only slight grinding to condition cutting edges are frequently serviced at the working sites by portable pneumatic sharpeners.

A drill that is well taken care of, fitted with the right drill steel and bit and properly handled is an effective piece of equipment provided it is supplied with a full head of air. With the exception of one central compressor plant along the entire route, portable units are furnishing the large volume of air used on the job. Most of the latter are high-output machines, a size bracket in which great strides have been made in recent years both in design and performance. For example, a modern rotary compressor delivering 600 cfm of air at 100 to 110 psi, which is sufficient to serve two heavy wagon drills, is approximately of the same size and mass as a 315-cfm machine of a few years back.

Taken in the aggregate and not including the bridge across the Hudson River, which is an engineering feat in itself, the structures along the right of way represent a big task. Inasmuch as the specifications stipulate that there shall be no crossings at grade, some 500



ROTARY GIANT

First in moderately hard siliceous limestone near Batavia (below) and later in shale near Little Falls (left), The Lane Construction Corporation has been using a Quarrymaster fitted with a rotary drilling element to give it greater speed. It can be converted in a few hours to a percussion-type machine suitable for drilling the hardest rock.

bridges will have to be built, as pointed out in the previous article. In Thruway terminology, the word "bridge" applies to any structure of single or multiple span with an opening of more than 20 feet measured along the center line of the highway. Anything less than that is called a culvert. It is estimated that one million cubic yards of concrete and 178,000 tons of structural steel will be needed for bridge construction. The former, added to the amount required for the 9-inch-thick concrete pavement laid on top of a minimum 4-foot course of frost-free material, necessitates the use of numerous large-scale batching plants and high-capacity cement, aggregate and concrete-handling facilities.

The Lane Construction Corporation of Meriden, Conn., was awarded the greatest mileage and dollar volume of contracts entailing the building of ten sections with a total length of 74 miles at a cost of $46 million. Four of them cover the full job of grading, paving, and building structures, one is for grading and paving, one for paving and structures, two for structures only and two for interchange installations. Their scope and diversity called for the amassing of much equipment to insure on-schedule completion of the many operations. Found on Lane jobs, and typifying the heavy earth-moving machines on all the grading contracts, are Le Tourneau and Gar Wood 23-yard scrapers drawn by Caterpillar, Allis-Chalmers and International crawler tractors; P&H, Bucyrus-Erie, Lima, Lorain and Marion power shovels and draglines up to 3½ yards in capacity; Euclid 25-yard bottom-dump wagons and bulldozers up to the largest size.

Two of the corporation's contracts call for large-scale rock removal. One, for a 10.46-mile stretch near Batavia included cuts through tough and abrasive siliceous limestone. Some drillers would characterize that rock as bordering between hard and soft, which presented a problem as to the selection of large-bore drilling equipment. For that work an Ingersoll-Rand Quarrymaster equipped with a rotary drill was used effectively to put down blastholes 6 inches in diameter.

Self-contained and self-propelled, this fast-drilling machine offers the unique advantage of convertibility, making it suitable for service in a cut or quarry where the nature of the rock varies. By simply replacing the rotary drill in the tower with a percussion drill, the rig is ready to bore hard rock, and it takes only a few hours to make the change. This is a relatively new feature of the unit which, regardless of the type of drill, is equipped for controlled drill feed and automatic hole cleaning without the use of water.

As mentioned in the preceding article, the Thruway leaves the Mohawk Valley between Schenectady and Utica for a short stretch to avoid the pinched floor at Little Falls. This town, incidentally, boasts the highest lift lock—40½ feet—in the New York State Barge Canal system. Much of the original Erie Canal and lock chamber at this point was cut by hand drilling and black-powder blasting of the very hard traprock which, reportedly, has caused more than one modern contractor "to go broke." That may have been another reason why it was decided to skirt Little Falls.

To follow the detour and to stay within the 3 percent maximum grade limit set, The Lane Construction Corporation has undertaken to excavate the largest single rock cut along the highway. About

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Removing snow from the streets in Glenwood Springs, Colo., is no problem. Water that issues from springs at 165°F is sprayed under pressure from city sprinklers to flush the white stuff away. The method works well only when the air temperature is above freezing, but there are few days in the winter when it doesn't warm up that much.

HILL TAMERS

Operating on the steep slope shown, these Brewster-owned wagon drills were held in position by a wire rope running from an air hoist on each machine to a steel pin driven into the hillside. With planks and blocking they were given somewhat level footings. These Ingersoll-Rand units were starting benches on which heavier drills and large muck-handling equipment could be operated.

1½ million cubic yards of rock must be removed from a hill that rises gradually on the western and abruptly on the eastern slope. Two fortunate conditions exist there. First, the rock is mostly a thinly stratified shale that is easily drilled and breaks well with reasonably light explosive charges; second, heavy fills being made on both sides of the cut shorten the haulage distance, with all muck moving downgrade. Atlas Powder Company Apex No. 3 dynamite in 5-inch cartridges holding 25 pounds of explosives each is used for blasting. Firing is done with 0 to 9 millisecond delays.

George M. Brewster & Son, Inc., had three percussion Quarrymasters on a grading job in 7½ miles of rough country between Whiteport and Kingston. This work was carried out under a subcontract from A.E. Ottaviano, Inc., and called for the excavating of 633,000 cubic yards of rock and the handling of some 1,200,000 yards of earth of which about half was borrow material. On this section, wagon drills performed operations that are normally done laboriously by hand-held drills. Provided with small air hoists, from which lines were attached to pins anchored in rock, they were held firmly while putting blastholes in precipitous slopes and jagged ridges to provide level places for Quarrymasters and other heavy equipment.

The rock varied considerably throughout this stretch of the Thruway, but it all fell into the "hard" class. The Quarrymasters used 6-inch Carset bits, and drilling progressed at the average rate of 15-18 feet per hour. Bit life exceeded 4000 feet of hole, with sharpening necessary after every 350-400 feet. The twelve Ingersoll-Rand wagon drills on the job were equipped with tungsten carbide-insert bits, and drill bosses counted on 400-450 feet of hole per drill each 8-hour shift. Most of the blasting was done with 40 percent strength American Cyanamid explosives.

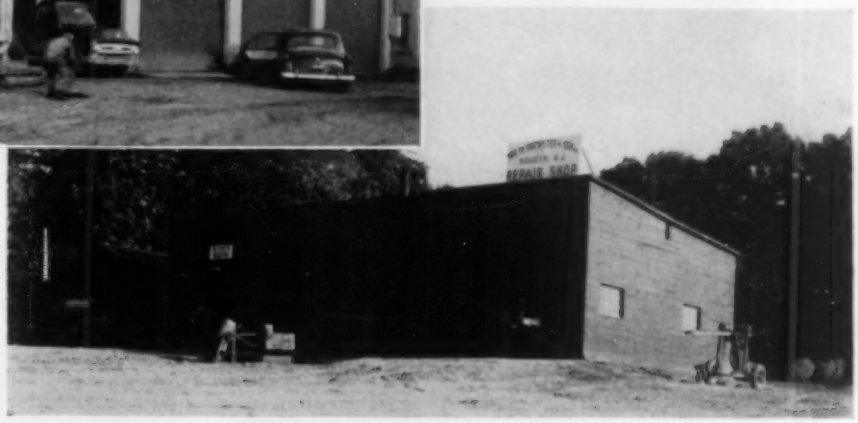
On the far-flung Brewster subcontract, air was furnished by numerous portable compressors: seven Gyro-Flo units of 600-cfm capacity, several truck-mounted 500- and 315-cfm machines and a 2-wheeled 105-cfm, all of Ingersoll-Rand manufacture. Four Bucyrus-Erie shovels—two 5-yard electrics and two 2½-yard diesels—and one 2-yard Lorain dragline and two 1-yard backhoes, a Thew and a Bucyrus-Erie, handled the broken rock and dirt, which was hauled away by about 40 bottom- and end-dump Euclids of 12 and 20 tons capacity and fifteen 14-yard end-dump Macks. Some twenty Caterpillar bulldozers headed the list of miscellaneous earth movers, which included a Euclid elevating grader—an effective piece of equipment.

In keeping with the average of more than one structure per mile of Thruway, the 7½-mile section requires nine bridges, which are now under construction by A.E. Ottaviano, Inc. Three will span railroad tracks, five will be at road crossings and one will carry the highway over Esopus Creek on the western edge of Kingston. One of the major functions on this contract, as well as on others, is the driving of sheet piling for the purpose of protecting railway roadbeds while bridge footings are being placed nearby and building cofferdams at stream crossings or at waterlogged sites. Because compressed air is always available on a construction job of the magnitude of the Thruway to power excavating equipment, backfill tampers, grinders, riveters, wrenches and many other air-operated tools, Ottaviano is using both pneumatic and steam pile drivers—the latter in areas that are readily accessible to the heavier type of rig.

The Savin Construction Corporation, of East Hartford, Conn., holds six con-

COFFERDAM

To build a cofferdam to facilitate bridge construction on the outskirts of Kingston, A. E. Ottaviano, Inc., used a McKiernan-Terry pile hammer operated with air supplied by a Gyro-Flo portable compressor to drive Foster sheet steel piling handled by a Lorain crane. This contractor is erecting nine bridges on a 7½-mile section of Thruway.



NERVE CENTERS

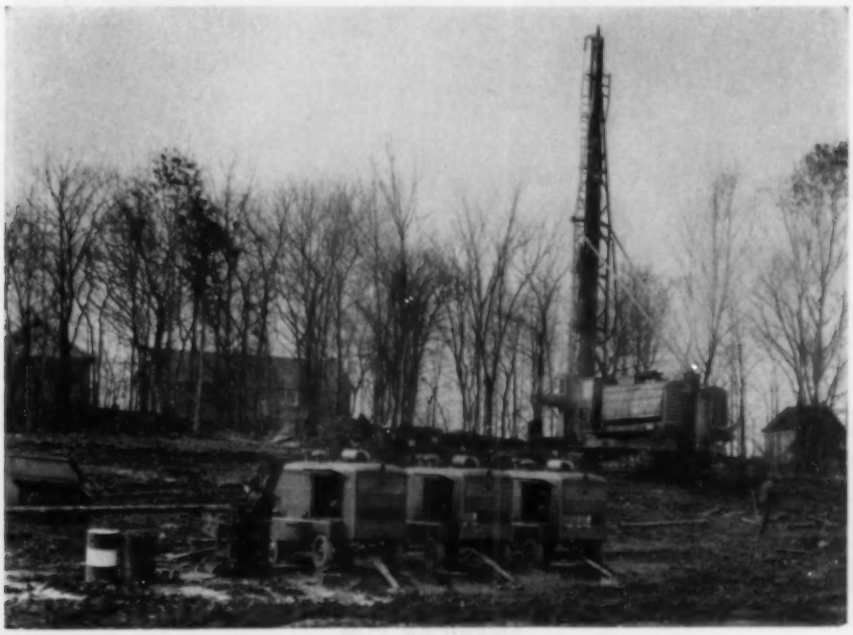
Contractors' field headquarters often include an equipment repair shop, stock room for spare parts, fuel and lubricating oil depot, offices for engineers and supervisors, and 2-way radio communication systems. Shown are the Brewster base near Kingston (below) and the Savin headquarters near Ravena.

tracts, four of which have a total length of 20.4 miles and extend south in Greene County from the Albany County line. There the firm is doing all the work, which includes the building of fifteen structures. Some of these, such as the span over Catskill Creek and a tunnel underpass, are major operations. The right of way throughout most of this section lies within the broken foothills of the Catskill Mountains separated from the west bank of the Hudson River by from 1 to 4 miles of highly developed real estate, networks of public utilities, highways, and railway systems. More than three million yards of rock and approximately one million yards of earth have to be removed to establish the Thruway grade.

On-schedule completion of this stretch of the toll road called for a multiple-point attack with a formidable array of equipment. Eleven power shovels—ranging from a 4-yard Marion down through P&H, Bucyrus-Erie, Northwest and Lorain units to a ¾-yard size—were on the job last December. In addition, Savin Corporation put nine P&H, Lorain and Lima draglines to work at structure and other sites. Four of this group are of the truck-crane type. Numerous crawler-mounted tractors and some 20- and 30-yard twin-engined and tractor-drawn scrapers were assembled to speed up earth-moving, and many trucks and wagons of different makes and capacities—from 13 to 36 cubic yards—haul the excavated material to disposal areas.

The underpass previously mentioned is located some 21 miles south of Albany where State Highway 81 crosses the new route. Locally known as Mushroom Road because of its proximity to one of the world's largest mushroom-growing buildings, the existing highway and a small stream go through a ravine which necessitated heavy rock cuts on both sides for the Thruway. At this point, Route 81 will pass through a tunnel of 3-radius arch construction. It is 36 feet wide at the base and on a 7.75 percent grade throughout its length of 260 feet. The arch is of double-reinforced concrete 2 feet thick and will be topped with 33 feet of rock fill. A total of 244,600 pounds of reinforcing material was required to help support the great weight of the fill, which will call for the use of 250,000 cubic yards of rock.

As is generally the case on big road-building jobs, maintenance and repair of equipment has been given prime consideration, for failure of a key piece for even a few hours may tie up work and cost a contractor thousands of dollars. "Keep it running in peak condition throughout the life of the contract" is the order on every machine. Where several major operations are in progress simultaneously along a stretch extending for miles in open country, it is important that this be done. Shops are therefore well manned and outfitted, stocks of spare parts are large, and service trucks travel back and forth supplying units in the field with water, oil, grease and fuel. Some of them carry compressors to inflate tires and to operate pressure lubricators, others welders and special tools to make repairs on the spot. In fact, everything that may be needed is made readily available so serious delays will be avoided and the work completed on schedule.



AIR PLANTS

Portable compressors furnish most of the air power for Thruway construction. The three Gyro-Flo 600-cfm rotary units in the foreground were operating wagon drills out of view on the left. The Quarrymaster beyond them carries its own air source—two reciprocating compressors.

SHOWPLACE FOR TREES

New Jersey community is planning an arboretum on its high-school grounds

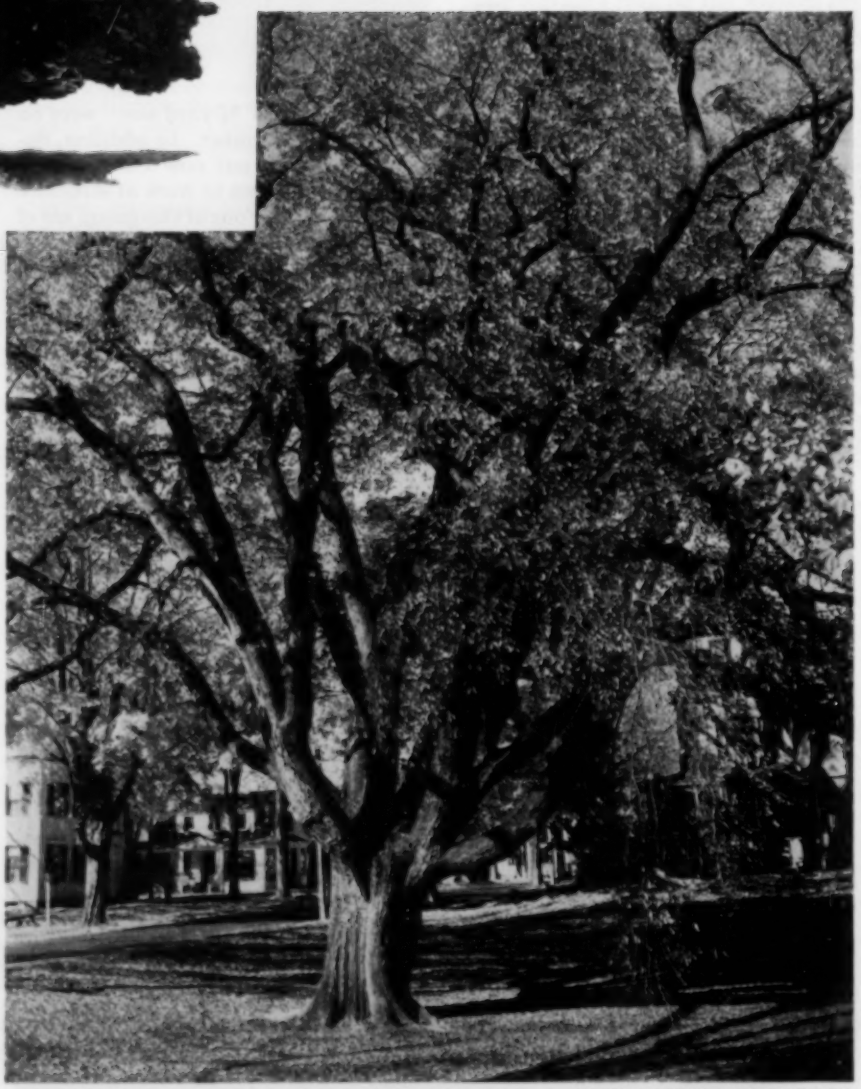
Harvey Morgenstern

SUGAR MAPLE

A favorite on suburban streets and country roads, the sugar maple is one of nearly 100 species that grow in virtually all of eastern North America. This variety supplies the bulk of our maple lumber, which is generously used for cabinet work and furniture because it is strong, close-grained, and takes a good polish. It is also, of course, the source of toothsome syrup and sugar, especially in the northern latitudes. There, each spring, an average adult tree yields 15 to 20 gallons of sap, which will boil down to about one-third gallon of syrup.

OF ALL inanimate things, trees are probably the most serviceable to mankind. From time immemorial trees have been the source of many human necessities. In addition to furnishing numerous varieties of fruit foods, they provide the primary material for human shelter. They have a marked effect on weather and moisture control and aid in the prevention of soil erosion. They offer shade and protection from wind; there is no "dust bowl" where trees abound. And in themselves they are such magnificent creations that it is a dull soul indeed that is not inspired by their beauty.

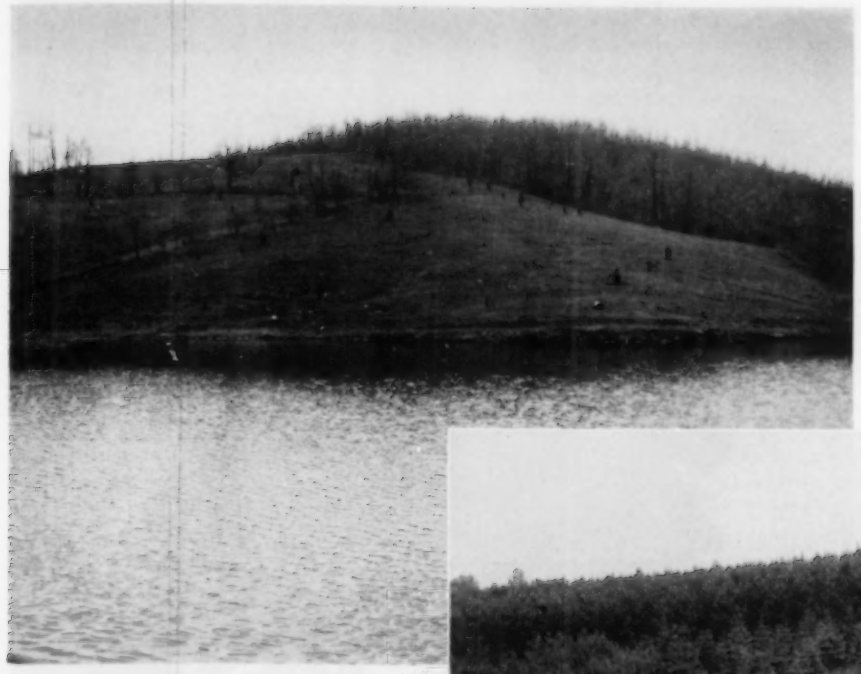
But despite their value to mankind, unintelligent and ruthless squandering of our greatest national forest asset prompted the late Lord Northcliffe, after his last tour of the United States in the late 1920's, to say, "The one dominant thing about the United States of America . . . is her people's wanton waste of their national resources. I mean particularly her forests, and if America does not wake up and immediately



PHOTOS A. DEVANEY INC., NEW YORK

AMERICAN ELM

Typically vase-shaped, the elm is of the nettle family and there are sixteen species of the genus *ulmus*. It grows in river bottoms and on low hills from Newfoundland to Florida and westward to North Dakota. It commonly attains a height of 80 to 100 feet and a trunk thickness of 2 to 4 feet. Its wood is tough and has been used among other things for shipbuilding and making barrel staves. The picture shows the famous Lafayette elm at Kennebunk, Maine.



TREES CONTROL MOISTURE

Americans have paid dearly to learn that areas deprived of trees and other growth erode rapidly and suffer a decline in water level. Conversely, planting trees conserves moisture and decreases run-off. These pictures show a small section of a watershed from which a New Jersey industrial plant obtains its water supply. The one at the left was made soon after the reservoir was built and reveals a denuded slope on one side of it; the other, taken eight years later, shows the result of planting red pine.

realize the necessity of conservation and reforestation, she will not only bankrupt herself but bankrupt the world."

Fortunately there has been an awakening, and under the urge of necessity we have instituted replanting programs on such a scale, principally in our major lumbering areas, that continued reproduction on a "crop" basis seems assured. However, in many sections this conservation effort has not developed to the extent hoped for, if at all, and millions of acres denuded of their former glory are barren and eroded, or at best covered with useless brush and scrub growth.

I have vivid recollections of the era of 50 and more years ago when logging in northeastern Pennsylvania and northwest New Jersey was a major industry. Great rafts of logs were floated down the Delaware River on the spring "freshets," supplying raw material to dozens of sawmills along its course. Those days are gone, and now the chief source of lumber is the Deep South and the Northwest. It doesn't make sense. Would that we could again hear the old familiar musical whine of the saw in our Delaware Valley, or your valley.

Once the economic significance of the forest is appreciated, the individual begins to realize that it is composed of trees. And when he sees trees in their full, awe-inspiring beauty, he becomes a conservationist. The planter of trees has an enduring interest in them. There is satisfaction in watching a seedling progress to a size sufficient to be a home for nesting birds, and from there onward until a mighty trunk supports staunch arms reaching heavenward as if invoking a blessing on him who nurtured it.

No individual can plant a forest. Relatively few can plant an acre. Yet millions of urban dwellers, where circumstances permit, could beautify their properties with one or more suitable trees. Many American towns are famous for their trees. Residential communities too often are unaware of the value of shade trees. They either aren't there, or are of species not suitable for the purpose, or they are poorly located and lack proper care. Planting trees where street paving or concrete sidewalks preclude an adequate supply of moisture is unpardonable. And in the event one so placed should survive and attain appreciable size, there enters the problem of roots heaving the sidewalk and paving and other adverse factors that may entail considerable expense.

At best, a tree on a city street is out of its natural environment, despite the beauty it adds to the community. Therefore much consideration should be given to the genera and species used and ample space provided for them. State departments of forestry or agriculture may be helpful in making selections. The idea of beauty is fully satisfied only when a tree is normal in form, vigorous in growth, healthy and suitably located. All of which leads to our theme: how can urban dwellers, and especially children, be made to appreciate the beauty of trees more fully and become better acquainted with the varieties so liberally provided by nature.

A tree is not just a tree; it is a specimen of a class or genus, and as such has its individual characteristics. How many can the average person identify? What is the historical or botanical background of, for example, the gingko? Geologists believe that this tree has been on earth for more than 200 million years. It is sometimes referred to as a living fossil. Almost exterminated during the glacial periods, and later attacked by a blight, it is reported to have been saved by Buddhist monks who protected and cultivated a few units in their gardens. And so we have it today as a valuable, exotic ornamental.

In the relatively small town of Phillipsburg, N.J., the idea of establishing an arboretum, preferably as an adjunct to the public-school system, has been nurtured for some years. Early in the summer of 1953 it was recommended that the Rotary Club sponsor such a

movement as a feature of its community service. The proposal was well received. A prospectus was prepared, approval given by the board of education and an administering committee was named. Of necessity, the latter has proceeded in a conservative manner, but fair results have been achieved. It is understood that the project shall be a continuing one, and a number of years will and should elapse before full planting of the designated area is accomplished. It is an enterprise calling for participation by the school children and the public at large. The prospectus as submitted, follows:

"An arboretum may be broadly defined as a botanical garden, as such containing specimen trees, shrubs, vines, flowers, etc., generally grouped according to the genus and species thereof, and in its fuller development, including a conservatory and numerous other associated facilities. An arboretum may also merit its designation by consisting primarily of an area planted with trees of various kinds, suitably marked for identification. With some exceptions, a single tree of each species may be adequate, but dual plantings are desirable, probably necessary in the case of the dioecious* types.

"Trees of the same genus are usually grouped to facilitate identification and comparison of species. Each tree, shrub, etc., is identified by a label or sign of moderate size, readily legible, giving both the botanical and common names. It therefore follows that the extent to which such an institution is developed is contingent upon such factors as available land area, initial cost of preparing the planting area, cost of plantings, annual cost of maintenance, supervision, extension of plantings, etc. Development in any degree within the foregoing limitations would provide at least the elementary features of a project generally regarded as being of public interest and educational value, as well as being a stimulus to improvement of unsightly areas elsewhere in the community.

PHOTO A. DEVANEY INC., NEW YORK

STURDY OAK

The oaks of the United States may be divided into white and black varieties. One of the latter is the red oak, pictured here. Although attractive and the most widely distributed member of the family, it is not as valuable commercially as the white oak, which yields about half the oak lumber cut in the country and is used wherever strength or beauty is wanted. Some white oaks live for 800 years.

*A study of trees is incomplete without the inclusion of the seeds. Inasmuch as some tree species have male and female flowers on different trees the planting of male and female trees becomes necessary. Trees having both male and female flowers on the same tree are termed moenecious.

* * *

'Old Man,' cried a fellow passing near,
'You are wasting your strength with planting here,
Your journey will end with the ending day
And you never again will pass this way,
You have crossed the chasm deep and wide,
Why plant a tree at eventide?'
And the planter raised his old grey head,
'Good friend, on the path I have come,' he said,
'There followeth after me today
A youth whose feet will pass this way,
He has not come to twilight dim,
Good friend, I am planting a tree for him.'

* * *

"We hold it to be of outstanding importance that the American public particularly the urban population be awakened and educated to the importance of trees as a national asset and the need for conservation. Our losses of this great resource through ruthless cutting and fire have been appalling. We have sufficient evidence in the present condition of the nearby Pocono range. Much

DAMAGE FROM STORM

Ice storms occasionally wreak havoc with trees in the northeastern section of the country, a fact that should be remembered when selecting varieties for residential planting. Regular pruning also may save a tree from the fate pictured here.

fire loss can be attributed to city hunters, picnic parties, and motorists who are indifferent to or ignorant of the consequences of their careless acts.

* * *

Upon the mountain-side and in all the valleys his branches are fallen and his boughs are broken—and all the people of the earth are gone down from his shadow and have left him.

—Ezekiel

* * *

"We believe also that a large segment of our people recognize in trees the miracle of beauty so ably expressed in Joyce Kilmer's famous poem. But it is unfortunate that so many lovers of trees are limited in ability to identify the various kinds, often due to lack of opportunity.

* * *

No man can be far wrong in temper of mind or in way of life who really loves trees.

—John Ruskin

* * *

"And we further feel that our school children should be instilled with appreciation of the value and beauty of trees, and given opportunity to become acquainted with the various kinds; to know for example that there are at least six different species of maple (*acer*), and eight of oak (*quercus*), indigenous or readily adaptable to this area, to know their individual characteristics as to appearance, utility, etc., and to be able to visually differentiate. There is a marked difference between the abstract of the botany classroom and practical knowledge in the field.

* * *

He who has never heard the voice of the trees is poor in knowledge.

—Chronicles

* * *

"In addition to the native utilitarian trees such as oaks, maples, pines, ash, hickory, poplar, tulip, sycamore and such, there are numerous exotic species which are adaptable to this area and should be of great interest."

* * *

When we plant a tree we are doing what we can to make our planet a more wholesome and happier dwelling place for those who come after us, if not for ourselves.

—Oliver Wendell Holmes

* * *

The proposed site of the arboretum is an unused section of the Phillipsburg high-school grounds, an area of 8 or 9 acres that now harbors an unsightly, uncurbed growth of brambles and some trees that receive no attention. This, it is hoped, can be cleared without much expense by using town or school-board labor during slack periods. Under such an arrangement the financial outlay required to get the movement underway would be small, and an initial appropriation of as little as $500 has been suggested. It is hoped to get this from the school board.

Once started, the arboretum would perhaps grow through public interest in it. The town commission would be empowered to supervise maintenance and disposition of all existing trees and shrubs on the high-school property; to plant additional trees, shrubs, perennials, etc., as resources and space became available; to accept and encourage contributions of acceptable types by local organizations, groups and individuals; to procure and place suitable markers bearing the names of the donors; and to further encourage such plantings as living memorials to deceased members of the Armed Forces. The group also would be authorized to set up regulations, to be revised or modified as necessary and subject to the approval of the school board.

Attached to the prospectus is a list of trees recommended for inclusion in the arboretum. It consists of 43 types and 93 species.

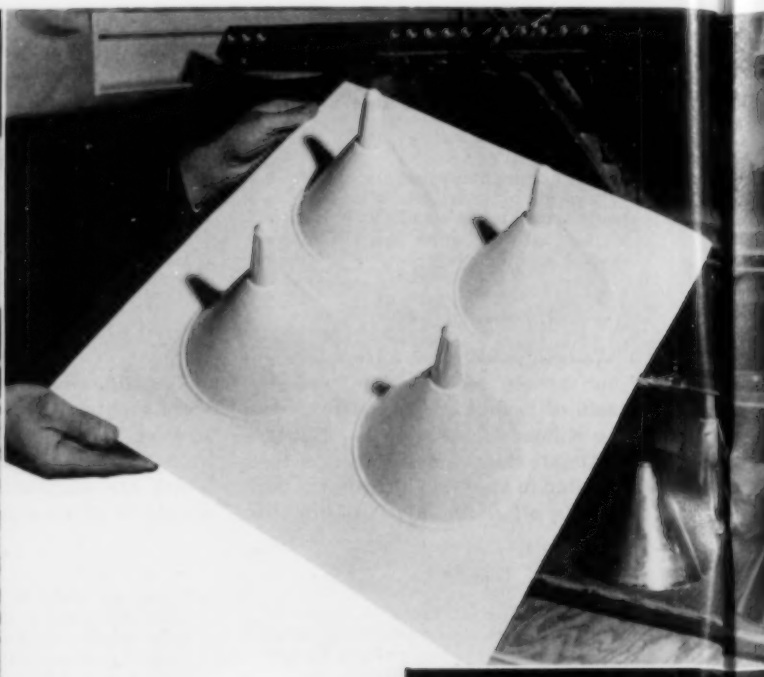
INCOMPATIBLE

An unfortunate combination of tree, utility pole and wiring in a residential section.

PHOTO A. DEVANEY, INC., NEW YORK

THE POPULAR POPLAR

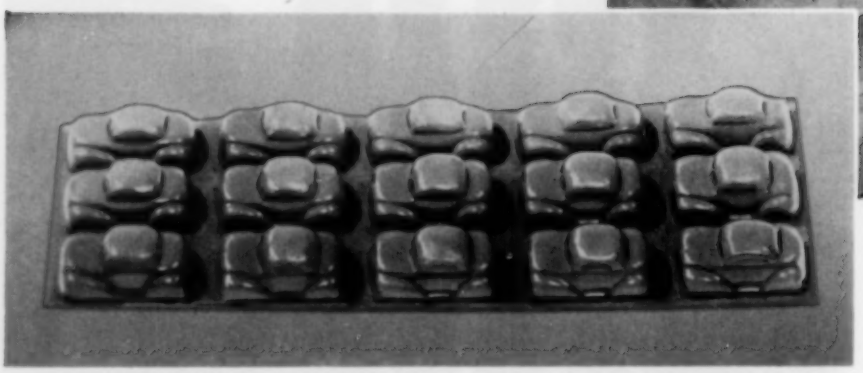
There are eleven members of the poplar family in the United States, two of the best known being the quaking aspen and the cottonwood. The latter, because it grows rapidly, is often planted for shade in the treeless plains west of the Mississippi River. It is frowned upon for city planting—even being prohibited in some places—because its shallow root system upheaves sidewalks and clogs drains and sewers. The poplar is of ancient origin, and its Latin name *populus* is thought to refer to an early Roman expression, *arbor populus*, meaning people's tree. The wood is soft and is used mainly for making boxes, crates, excelsior and wood pulp. The poplars pictured are along the Muddy River, The Fenway, Boston, Mass.



NEW PROCESS

Vacuum Forming of Plastics Gains Favor

C. H. Vivian

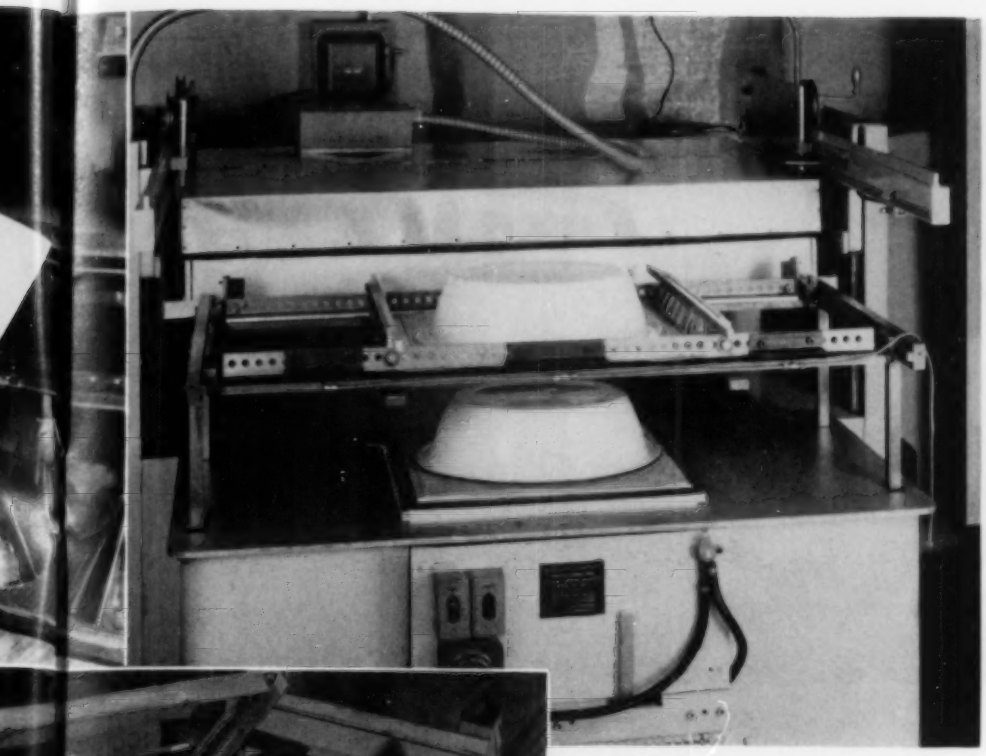


ARTICLES composed of thermoplastic materials have commonly been manufactured by melting a powder and injecting the resulting liquid into molds. By a newer method called vacuum forming, which is fast gaining favor, a heat-softened sheet is drawn into a mold by means of suction. In the older equipment designed to do this the sheet is transferred to the mold after being softened, but the Auto-Vac Company, of Fairfield, Conn., has developed a machine in which the sheet is heated while it rests in position on the mold. This has shortened the operating cycle and consequently reduced the production cost.

Vacuum forming has its limitations, of course. The process is not suitable for making all thick or deep articles, or those with complicated interiors or that require molded-in inserts, but it will turn out many items at a lower unit cost than injection molders can meet. Where it is applicable, the newer method has definite advantages. For one thing, it will produce larger pieces than even the biggest injection equipment. Some of the vacuum machines now in service have platens 30 feet square and are capable of forming an object weighing 25 pounds. On commercial runs, they may handle from 350 to 400 pounds of plastic per hour and up to $400,000 worth in a year. And while Auto-Vac units are in the $10,000 range, a 200-ounce injection molder may run as high as $200,000. In many instances the entire Auto-Vac equipment comes to less than a single mold for an injection machine.

Chiefly because the sheet plastic used in vacuum forming is generally stronger than the material obtained by melting powder, it is practicable to make articles with thinner walls. As a result, the new technique is creating a field of its own. Thicknesses of from 0.01 to 0.03 inch are common, whereas the same items, if injection molded, would be from 0.06 to 0.09 inch thick. Consequently, even though sheet material costs from 1½ to 2½ times as much as powder, it is normally just as economical and sometimes more so.

The leading products of the Auto-Vac process are advertising and Christmas displays and deep-embossed component



EXAMPLES OF PRODUCTS

The diversity of objects that can be made by the Auto-Vac process is illustrated here. The large spoons were designed by Oneida Ltd., silverware manufacturer, for exhibition purposes. They were formed by Displaymasters and metallized by Gomar, both New York firms. The funnels were molded four at a time and the toy automobile bodies fifteen to a sheet. The Halloween masks shaped and printed and ready to be die cut, were manufactured by the Topstone Rubber Toy Company, Bethel, Conn. An untrimmed dishpan is shown on the press which formed it.

parts for industrial and household machines and appliances. Among the many other things being manufactured are toys, air mattresses, suitcases, typewriter and cosmetic cases, rigid handbags, tops for office furniture, aprons, TV masks, shower curtains and bath mats, tablecloths and place mats, as well as doors, ducts, etc., for air-conditioning installations, and reflectors, ceiling panels, decorations, illuminated and unilluminated signs, butter trays etc. The most important items now under development are packaging materials, visual and profile containers, snap-on lids, inflatable novelties and lighting fixtures.

A few figures will reveal the rapid growth of vacuum forming. In 1950 only three commercial fabricators were equipped for it, and they had twelve machines in all. Early in 1953 there were 75 active shops with 150 machines. The industry is still considered to be in its infancy.

As to raw materials, various sheet plastics are suitable, but the rigid vinyl copolymers are most used, especially for making relief maps, store displays, containers, toy parts and lighting fixtures. Flexible vinyl is utilized for deep embossed products such as bath mats, wallets and ladies' pocketbooks. Components of refrigerators, shower baths, washing machines, radio cabinets and many other household articles are molded from styrene copolymers, while cellulose acetate, straight styrene sheet material and polyethylene and Teflon also are used in varying quantities.

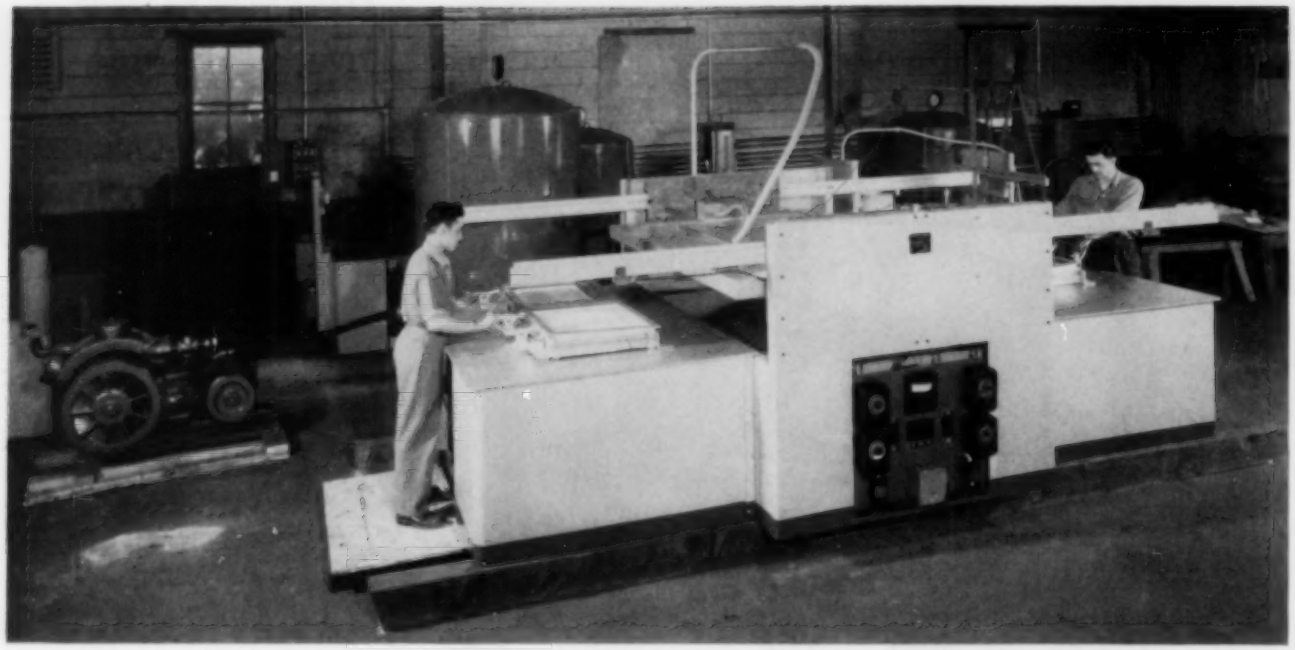
The method is especially advantageous where products are to be decorated with colors because the latter can be applied to the flat sheet before it is formed. In doing this, the design is purposely distorted in such a manner that the different colors will be in their desired places when the sheet is drawn into shape. They are put on either by silk screening or by one of the available printing processes, with lithographing in most common use. As many as may be required can be applied at one time to an area 8 to 10 square feet in size.

Preparing a silk screen for printing a sheet of 20x25 inches (one is needed for each color) costs around $40. The screening itself comes to about three cents per color for labor, and the paints run from $7 to $12 a gallon, or about one cent per square foot of area covered. The paints used must have good adhesive qualities and be able to stretch up to 100 percent during the molding operation without breaking or changing color appreciably.

Conventional printing of the plastic sheets is more expensive than silk screening, and is justified only on runs of at least 7500 to 10,000, which are generally considered necessary to bring over-all costs within reason. The plates required for lithographing an area of 8 square feet range from $75 to $200 per color, and printing amounts to approximately four cents per color. Because printing inks are designed to dry faster than silk-screen paints, they do not adhere so well to the plastic surface and call for overcoating with some suitable reagent to prevent them from rubbing off. Also, if the product is to be illuminated from within, many inks are too thin to give the desired color effect and double printing is needed to overcome this shortcoming.

An important contribution towards the economy of vacuum forming is the low cost of the molds. Those for relatively small runs are generally made of a hard plaster such as Hydrocal (U.S. Gypsum) or Densite (Certainteed Products) often reinforced with screening. They normally range in price from $30 to $40 per square foot, exclusive of the master cast. A clamping frame to hold the mold in position on the machine adds $20 per square foot to the outlay. After it is cast, the plaster mold is impregnated with a resin such as Bakelite's C8 epoxy, which gives it a hard, durable surface. Molds of this type have remained in good condition after producing 50,000 pieces.

Molds for longer runs are made by spraying metal on a master cast until a shell from $\frac{1}{8}$ to $\frac{5}{16}$ inch has been built up. This is removed and backed up with plaster or a mixture of resin and fibrous glass, the latter being sometimes preferred because of its lighter weight. The master cast may be of plastic, wood, plaster or rubber. In any case, it is carefully fashioned and rid of surface defects because all details are faithfully reproduced in the metal mold. The surface is usually blasted with fine sand, and a silicone parting agent is wiped on it so that the shell can be readily stripped off.



MACHINE IN SERVICE

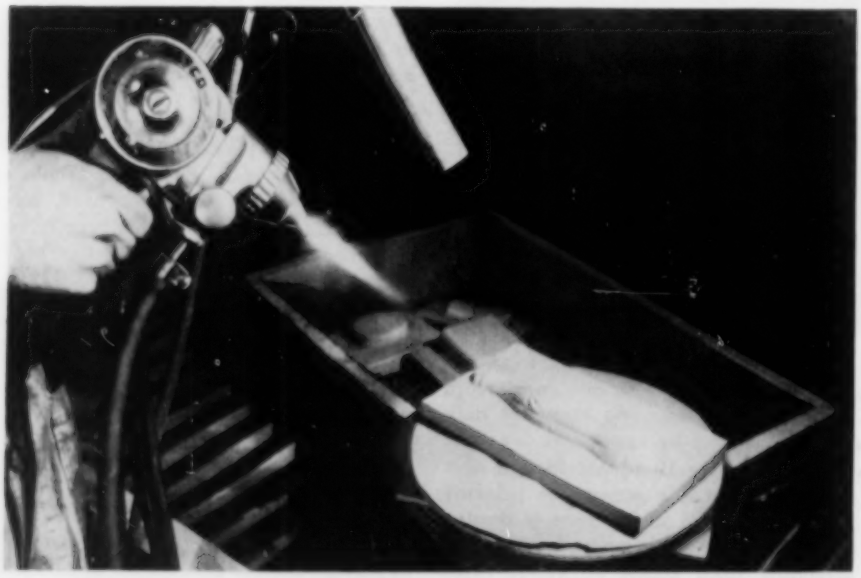
This is one of the largest Auto-Vac machines so far produced. At the left is the Ingersoll-Rand 7½-hp vacuum pump that serves it. The unit is connected to the 600-gallon tank in the background and the tank, in turn, to the molding machine. Six-inch piping and a 6-inch valve are used to produce the sudden surge of vacuum required to snap the plastic instantaneously against or into the mold.

A low-shrinkage compounded metal in which lead predominates is generally first sprayed on the master cast to a thickness of 0.005 to 0.020 inch and then covered with as many coats of a bronze compound as are required to produce the final thickness. Tin, aluminum, zinc and copper also have been used with good results. Costs per square foot are approximately $75 for spraying, $15 for backing up and $20 for the clamping frame.

No matter which of the two molds is utilized, it must have numerous tiny holes through which the air can be exhausted to draw a suction on the softened plastic sheet. They may be drilled in both the plaster or the metal type or, in the case of the latter, protruding pins may be inserted in the master cast and then pulled out after the work of spraying and backing up the shell has been completed.

In preparation for the forming operation the sheet of plastic, cut to proper size, is placed over the mold and a clamping ring is lowered and secured to prevent any leakage of air into the space between the sheet and the mold. An electric element, capable of supplying uniform heat up to 700°F throughout a large area, is next pulled into position over the sheet, usually within 1½ or 2 inches of it. When the plastic has softened sufficiently (it takes from seven to thirteen seconds per 1/100 inch of thickness, depending upon the kind of material used), vacuum is applied and the sheet is forced into the mold depressions by atmospheric pressure acting on it. After a short period to allow for cooling, the clamping ring is removed and the formed plastic stripped from the mold.

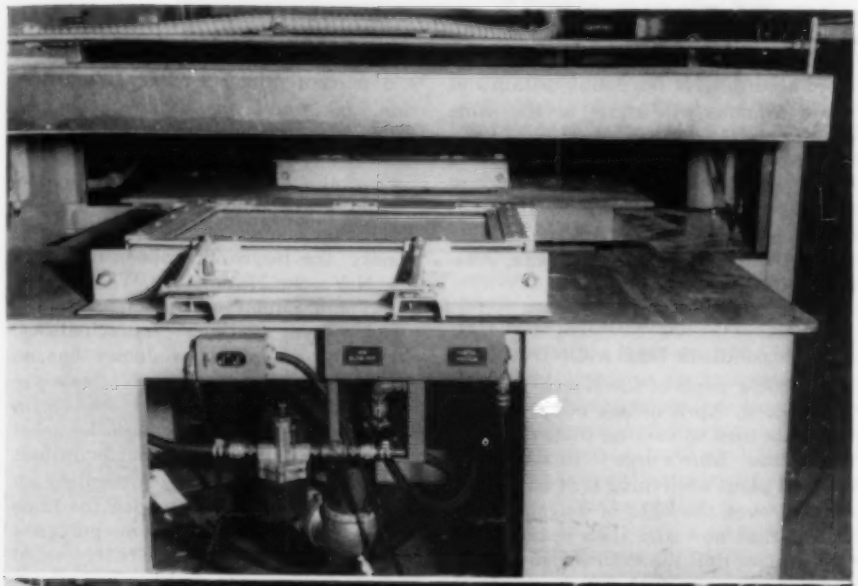
An adequate vacuum-producing system is, of course, a prime requisite if the machine is to function satisfactorily and uniformly, but as standard machines and accessories serve its needs no special equipment is required. The Auto-Vac is provided with an Ingersoll-Rand motor driven dry vacuum pump of from 2 to 10 hp and 18 to 166 cfm piston displacement. These units are designed to create a vacuum within one inch of the barometric reading. In order to insure quick evacuation of the space between a large-size plastic sheet and its mold, a tank with a capacity of 200 to 600 gallons (27 to 80 cubic feet) is interposed between the pump and the mold. Piping and hose lines are large (from 2 to 6 inches) and valves are of

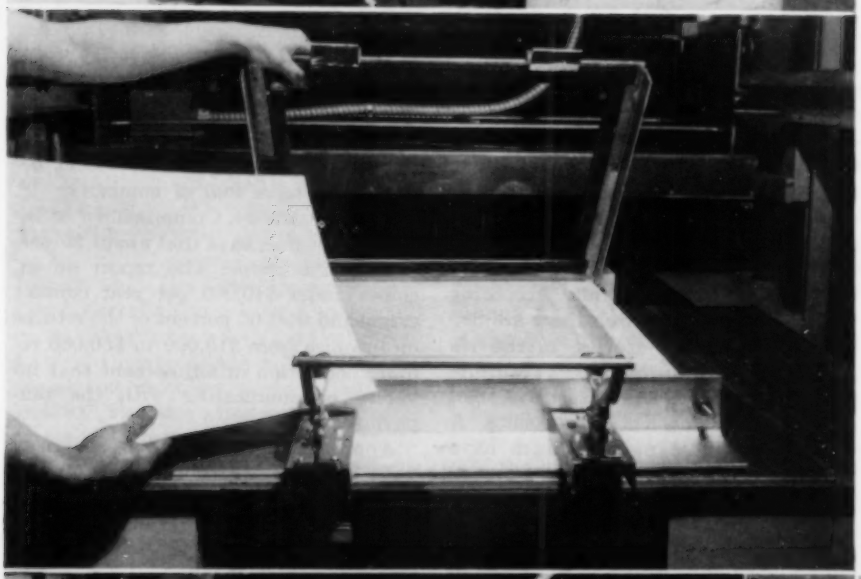


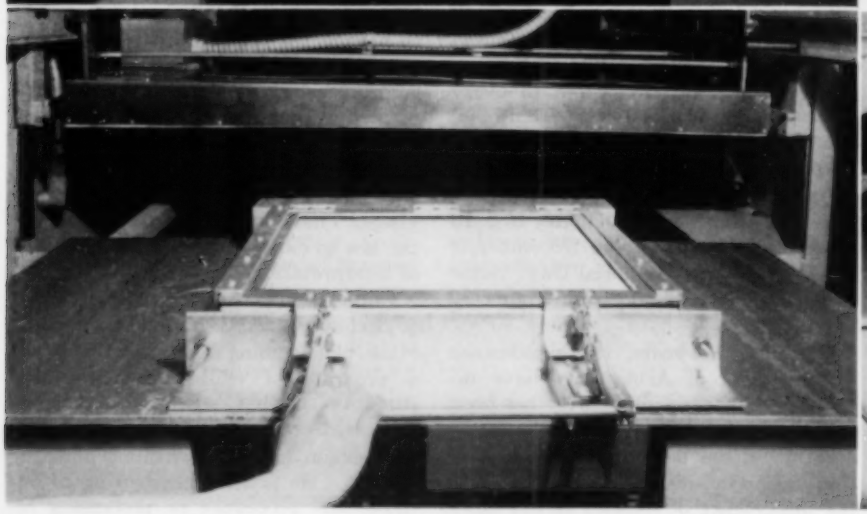
METALLIZING ENGINEERING COMPANY

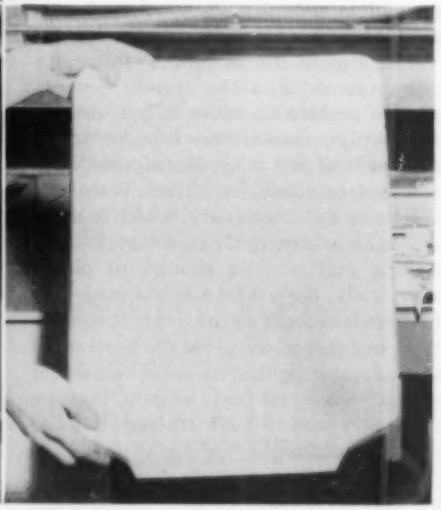
SPRAYING A MOLD

Molds for long runs are often made by spraying metal on a plaster, plastic, wood or rubber form until a shell from ⅛ to 5/16 inch thick is built up. This is removed from the pattern and backed up with plaster or some other material to make it rigid. The metallizing gun is air operated.









corresponding sizes. When a valve in the line leading to a mold is opened quickly, the vacuum asserts itself immediately and the softened plastic sheet is snapped into the mold so fast that it is drawn into even the tiniest recesses, thus assuring faithful reproduction of all contours.

Where relatively small pieces are being made, several identical molds are often utilized and the formed sheet is cut apart with dies and the use of special machines which the trade calls clickers and dinkers. They usually have a bed of wood, soft metal, or rubber against which the die does its cutting and cost from $600 to $3000, exclusive of the dies which run from $75 to $300 each. By handling them in stacks, thin-section parts having an area of around 1 square foot can be cut at a rate of from 1000 to 1500 per hour. Such multiple molding naturally increases the rate of unit production and reduces costs proportionately.

Because of their advantages, Auto-Vac machines are extending the range and usefulness of plastics by turning out articles that could not be made economically by any of the processes previously developed. Testing prior to setting up for production runs can be done inexpensively because of the comparatively low cost of the plaster molds. This means that, with little monetary outlay and in a short time, a plant can manufacture small quantities of new things to determine in advance of investing in durable molds and regular production facilities whether the demand for them justifies the greater expenditure. It is also a simple matter to transfer activities from one consumer field to another, using the same equipment and the same operating procedure.

SEQUENCE OF OPERATIONS

Top— Front view of an Auto-Vac molding unit showing the 4-inch vacuum connection underneath. Its large diameter insures almost instantaneous action in drawing the plastic sheet into the mold.
Center— As the first step in forming a plastic drainboard or sink mat a flat sheet of plastic is placed on top of the mold. A metal frame is then lowered and clamped down over the edges of the sheet so as to effect an airtight seal.
Bottom left— An electric heater is next pulled over the mold. After heat has been applied for a set time, a valve is opened quickly and the sudden surge of vacuum pulls the softened sheet into all the recesses of the mold.
Right— The shaped mat, having cooled sufficiently to regain its rigidity, is withdrawn and trimmed, as shown.

Editorials

WHAT IS ORE?

MINING men of the British Empire will meet in London soon to decide upon the meaning of a three letter word—ore. Their current definition implies that the word can be properly applied only to natural deposits that contain metal. The purpose of the gathering is, essentially, to try to broaden the meaning to include also deposits that yield nonmetallics. The reason for that, of course, is that the mining of nonmetallics has grown tremendously in recent years and thus created a problem for those who write about them. Broadening the word's meaning would make their jobs easier and their language less cumbersome and verbose.

It would seem that the British have created this linguistic difficulty for themselves by insisting on sticking resolutely to tradition. The word ore was derived from *ora*, meaning coins, and *ar*, for copper or brass. Both carry the connotation of metal. It is pointed out, however, by those who advocate the proposed change that numerous words in the mining lexicon have lost their original meanings. For example, *sphalerite* or *blende*, which now means zinc sulphide, once stood for something treacherous or deceitful, and *cobalt* and *nickel* were formerly designations for demons and goblins. Even *gangue*, which now refers to only the unwanted part of a vein or lode, meant the whole deposit in the original German. The Oxford dictionary, to which the British adhere rather closely, shows that the word *atom* comes from a Greek root meaning indivisibility. In this age of atom-splitting, a definition based on that precept is patently incorrect and outmoded.

The United States mining fraternity is not involved in the current nomenclature problem because it has already arbitrarily adopted the broader interpretation of *ore* without recourse to a conclave or discussion. Even Webster's International Dictionary, which is more or less an arbiter in this country, is clear on the matter. As though to please everybody, it gives two definitions. One of them is as strict as the British counterpart, but the second gives the word more latitude, stating that an ore is "a natural or native mineral that, usually, may be profitably mined and treated for the extraction of *any* of its constituents."

This interpretation is fairly recent, even in America. In fact, in 1909 the question "What Is an Ore" was discussed without any reference being made to nonmetallics. That was because virtually none of them was then being produced. When this condition changed, our mining people, without ado, merely broadened the meaning of the little word accordingly. No doubt Britain and her dominions will arrive at the same conclusion, but in their own formal way. The forthcoming meeting will be held under the auspices of the Institution of Mining and Metallurgy, which draws its membership from among mining men in the British Isles, Canada, Australia and South Africa.

APRIL IS TREE MONTH

IN MOST parts of the North Temperate Zone, April ushers in spring and thoughts turn to making things grow in the ground. Man's urge to turn over the soil and plant something is at its height, and not even the sight of wriggling fishworms that now and then come to the surface can dull his enthusiasm for the chore during the first few warm days. Later on, when he's had his fill of digging, it may be a different story.

Most of us must content ourselves with planting a few vegetables or flowers, and dwellers in large cities generally have to forego even these pleasures. Suburbanites, on the other hand, often can indulge themselves without limit and even set out trees. Everybody, it seems, likes trees. Even presidents have exhibited this common trait. According to a recent news dispatch there are 380 trees, including 93 species, in the 18-acre White House yard. Tradition dictates that each chief executive shall add a few specimens of his choosing. A check shows that most of them have been partial to the elm.

In Nebraska, on April 10, 1872, J. Sterling Morton, who afterward became secretary of the U.S. Department of Agriculture, originated Arbor Day. More than a million trees were planted and an enduring custom was established. Arbor Day is now observed in every state and in the District of Columbia, but not everywhere on the same date. Many southern states designate a winter day. It is a legal holiday in Nebraska (April 22) and Florida (January 20). In Arkansas, where it falls in December, it is combined with Memorial Day. Some states observe Bird Day and Arbor Day together.

Through the years, the significance and meaning of Arbor Day have increased. The planting of trees has been continued and even extended and, in addition, it has become the practice on that day to impress school children with the importance of forestry in our daily lives. Some places provide year-round tree education through the medium of arboretums. These displays of living native and exotic trees are an aid to botany teachers and a joy to all nature lovers. The custom of bringing together trees from near and far and arranging and marking them for easy identification and study has been followed in Europe from at least as far back as the sixteenth century.

Several fine arboretums exist in the United States, notably the Arnold (since 1869) that is operated by Harvard University, the Boyce Thompson in Yonkers, N.Y., the National in Washington, D.C., and numerous others under the auspices of various municipalities. Strangely enough, New Jersey has no public arboretum, although there are some on private estates. However, in the Town of Phillipsburg, the home of this publication, a movement is on foot to establish one. We are presenting an article on it in this issue with the hope that it may serve to give some guidance to other communities that are interested in fostering a similar enterprise.

IDES OF MARCH

IF YOU made a mistake or two in the income-tax return you filled out last month, don't feel too bad about it, because you have lots of company. T. Coleman Andrews, Commissioner of Internal Revenue, says that about 25 percent of the people who report on incomes under $10,000 per year commit errors and that 60 percent of the returns on incomes from $10,000 to $50,000 require correction or adjustment that involves communicating with the taxpayers.

Approximately 95 million American individuals or organizations file one or more of the 70 kinds of tax forms now in use, and income-tax returns number about 62 million. The Internal Revenue Bureau employs 55,000 men and women to process the forms and straighten out errors and misunderstandings, which are so numerous that the force is hard pressed to get its work done on time. It has an especially hard time, it seems, with the 10 percent of the returns that are filled out by professional tax advisers. These people sometimes "shave" the law so close that involved questions of interpretation result.

Commissioner Andrews has appealed to taxpayers to try to reduce their mistakes. He is going so far as to institute a program of educating high-school students so that when they become earners they will know how to give Uncle Sam his share without bungling the job. He is also endeavoring to improve the procedure of processing returns. Through these various efforts he hopes to lessen the unit expense of handling returns. If the plans work and some money is saved, Mr. Andrews expects to put it to a good cause: He's going to hire more agents to do a better job of checking on all of us.

This and That

Record Freight on Lakes

A record volume of dry bulk freight was moved by boats on the Great Lakes in 1953, the Lake Carriers Association reports. The total was just short of 200 million tons, with iron ore accounting for more than

half of it—107,345,783 tons. Next came 50 million tons of bituminous coal, 26 million tons of limestone and 14 million tons (547 million bushels) of grain.

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24-Mile Tunnel Considered

The National Railway of Japan is investigating the feasibility of constructing a tunnel between the islands of Honshu and Hokkaido to replace the existing ferry. The proposed bore would be 24 miles long, with 13 miles underwater. Honshu is the nation's largest island and the one on which Tokyo is located. Hokkaido lies just north of it, across the Tsugaru Strait. Daily traffic between the two averages 4649 passengers and 973 freight cars. The steamer route is 68 miles long and the passage takes 4½ hours. Test borings to a depth of 250 feet are being made to determine the character of the ground. Investigation and planning of the project are expected to take four to five years and construction between 20 and 30 years. The estimated cost is $140 million.

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Oil from Fire

Magnolia Petroleum Company, a subsidiary of Socony-Vacuum, is testing a scheme for thinning viscous underground crude oil with heat so that it can be pumped to the surface by the usual methods. Heat is supplied by burning some of the oil in place in the containing formation. It is ignited by lowering electrical elements and heating them to 1400°F. Once a fire is kindled, the elements are withdrawn and compressed air is blown down to supply oxygen to feed the flames.

Field tests were made in 1953 in a shallow Oklahoma oil field, and others are planned for this year. It is believed that a fire in a well in the center of a square area will radiate enough heat to extract oil from four wells—one at each corner of the figure. Further experimentation is needed to determine how small the square would have to be.

The indications are that about seven barrels of oil can be obtained for each barrel burned. The method would be applied to depleted fields in which the crude has become so thick that usual means of recovery will no longer work, or in areas that have never produced because the deposits are too viscous for pumping. In the latter category may be the Athabaska sand deposits of western Canada, where a tarlike oil has so far defied economical extraction. There is enough of it, according to some estimates, to fill the world's needs for a century at the present rate of consumption.

★ ★ ★

Air Keeps Channel Open

A 900-yard ferry route between two islands in Lake Maelar, near Stockholm, Sweden, was kept open during the past winter months by bubbling compressed air through the water from a pipe laid on the bottom. In former years, ice breakers maintained a channel at an expense of around $2000. The cost of the air installation did not exceed that sum, and it will be available for years to come. Air supplied by a compressor on shore is released from openings spaced about 11 yards apart in plastic tubing. Aeration lifts the low-lying warmer water to the surface, where it displaces the cold water and even melts thin films of ice. Although the temperature got down to minus 4°F, no trouble from freezing was experienced.

The method is comparatively new in Europe, but has been used in the United States for 25 years or more mainly to prevent ice from forming near dams and turbine intakes of hydroelectric power stations. In recent years it has been adopted by sawmills in northern latitudes to keep their log ponds open in cold weather and thus enable them to operate throughout the winter.

★ ★ ★

Rebuilding Famous Bridge

Europe's longest suspension bridge is being built for the second time. The original structure was completed in 1941, but wartime bombing destroyed it the following year. The bridge, which is 1840 feet long over-all and 1229 feet between towers, crosses the Rhine River as a part of the Autobahn, the original vehicular expressway. It will have two 28-foot-wide roadways, a lane for bicycle riders and a footwalk. The main cables, each composed of 61 multistranded wire ropes 2.1 inches in diameter, will pass over towers 195 feet high. The west pier, which suffered several bad vertical cracks when the structure was wrecked, was repaired by enclosing it within a cofferdam to exclude water, boring several horizontal holes through it, inserting cables and putting them under tension as is done in the case of prestressed concrete members.

★ ★ ★

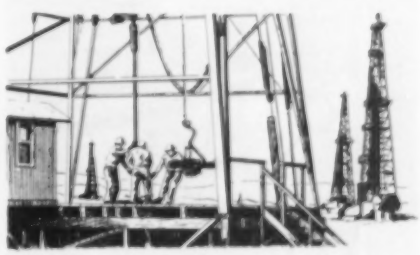
Money from Air

The air brake invented by George Westinghouse is not only one of the greatest safety devices ever conceived but also has been a pretty fair breadwinner for those who backed its promotion. Westinghouse obtained his first patent on the brake on April 13, 1869, and in the following September organized the Westinghouse Air Brake Company to make it. Five years later the firm began paying dividends to its stockholders and has continued to do so, without interruption, ever since. Only thirteen other companies out of the 1069 that have stock listed on the New York Stock Exchange can equal this 80-year record. To date, 305 dividends totaling $265 million have been paid. If, for example, $5000 had been invested in the enterprise in 1869 it would now have grown to an equity of $560,000 and yielded a fabulous $1,630,000 in dividends. Another concern in the same field, New York Air Brake Company organized in 1890, has likewise been consistently successful.

★ ★ ★

Stains Betray Leaks

In its Houston, Tex., factory the National Supply Company uses an unusual method to test wellhead assemblies that must safely hold in check the enormous pressures sometimes met at the tops of oil wells.



Before the assembly is shipped, it is filled with a special "wetter-than-water" fluid that seeps through even tiny openings if they exist. To it is added a fluorescent dye that glows green when

exposed to ultraviolet light. During the test the fluid is put under a pressure 10 percent greater than that of the industrial standard and is alternately applied and released quickly three times. In the final stage, the pressure is maintained while the entire assembly is carefully inspected under the rays of an ultraviolet spotlight. If there are any leaks, they show up as green stains.

★ ★ ★

Unique Power Plant

At Grahamsville, N.Y., in the heart of the Catskill Mountains, can be seen an unusual example of a private power company using part of a city's water supply to produce electricity. Early in March, Central Hudson Gas & Electric Corporation put in operation there a 25,000-kw turbogenerator that is turned by water emerging from one of New York City's aqueducts—a 5-mile, 10-foot-diameter tunnel that connects Neversink and Rondout reservoirs. The water descends 600 feet in that stretch, and 550 feet of the head is being used in a $2.7 million station built by the utility. Water passes through the turbine into Rondout Reservoir and thence through the 85-mile Delaware Aqueduct to New York. The flow through the tunnel will be increased daily during the hours when the demand for Central Hudson's power is at its peak.

The plant is an outgrowth of an agreement made in 1944 when the city began to divert from Rondout Creek water the company had been utilizing in a hydroelectric station. The pact gives Central Hudson free use of 3.2 billion cubic feet of water annually for 100 years and the right to buy the use of additional water if and when it becomes available. At the end of the century-long period the plant will become city property.

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Sleds of Supersonic Speed

In a desert setting at Edwards Air Force Base, in California, sleds driven at terrific speeds by rockets are used for testing parachutes and seat-ejection equipment without endangering personnel. Information on the larger ones is restricted, but some facts have been made public on one that weighs 2300 pounds and is capable of attaining velocities up to 1100 miles per hour. It was built for the Air Force by Northrup Aircraft, Inc. The sled travels on a track made up of two standard 115-pound railroad rails. It is 2 miles long and is said to be the straightest and smoothest in existence. It was laid with great precision, and the rails were aligned in the cool of the night to avoid error through heat distortion.

Wheels were considered to be impractical as running gear, and their place is taken by four skids or slippers. These have a cross section like a block-letter C lying with the open space downward, thus conforming to the railhead. Each slipper is hard-faced with Haynes Stellite at five points where contact is made with the rail. Before the runners were so treated they sometimes were good for only one trip, now they are normally used twelve or more times. Five rockets provide an aggregate thrust of 55,000 pounds to propel the sled.

★ ★ ★

Curbing Jack Frost

When the pressure of gas flowing through piping is suddenly reduced, a refrigerating effect is produced and generally causes frost to form. If the pipe is buried, the frost often spreads into the surrounding ground and makes it heave. This may result in damage if the line passes through or close to walls or other structures. Such a condition was overcome rather simply by United Natural Gas Company at Oil City, Pa.

For a distance of about 30 feet downstream from the reducing valve, the 6-inch gas line was enclosed in a 16-inch pipe which was welded gastight at each end. Air was then withdrawn from the annular space through a small connecting pipe by a vacuum pump. Evacuation, which created a thermos-flask effect, prevented frost from forming and stopped heaving, which had been evident as far away as 1000 feet. At a road crossing, where frost action had similarly pushed up the overhead fill and cracked the surface of the concrete roadway, the trouble was corrected merely by putting on a larger pipe or "sleeve." Evacuation of the annular space was found to be unnecessary because the contained dead air provided enough insulation to prevent the ground above from freezing.

Traveling Belt for Human Loads

CONSTRUCTION is to be begun by the Goodyear Tire & Rubber Company and the Stephens-Adamson Manufacturing Company on a passenger belt conveyor of rubber for the Hudson & Manhattan Railroad which serves commuters traveling between points in New Jersey and New York City by way of the Hudson River Tunnel. The contract calls for a "speed walk," 227 feet long and 6 feet wide, to connect the Erie Railroad Station with the underground Hudson & Manhattan tube platform in Jersey City.

The belt, with its handrails, is designed to move at a rate of about 1½ miles an hour and to reverse its direction so as to handle rush-hour traffic to Manhattan in the morning and homebound traffic in the evening. Throughout 125 feet of its length it will negotiate a grade of 10 percent and will therefore require a more powerful motor and braking system than was provided for an experimental conveyor of this type built by the two concerns (see our November, 1952, issue). In the meantime The B.F. Goodrich Company installed a moving sidewalk in Chicago's Museum of Science and Industry. This rubber belt is expected to carry about two million visitors a year past some of the exhibits at a speed that will enable them to see them well. Furthermore, by keeping the people moving, it will prevent congestion.

According to William A. Davis, general superintendent of the H.&M. Railroad, some 14,000 persons use the Hudson Tunnel daily. With the new transportation system, it will be possible to increase the pedestrian movement between the railroad station and the tube platform 50 percent. Because of the novelty of the installation, the cost, tentatively set at $75,000, may have to be adjusted.

"Sloo Foot, here, bets he kin stomp durn near as much fill as that thing, anyday."

"If he wasn't the boss' son, I'd let him learn the hard way."

Multipurpose Grinding Wheel

GRINDER AT WORK

Removing flash from the end of a casting with an Ingersoll-Rand grinder equipped with a Norton semiflexible, reinforced resinoid-hub wheel.

ROUGH-GRIND, finish-grind, and notching operations can now be done with one grinding wheel, a semiflexible, reinforced resinoid hub wheel developed by the Norton Company, of Worcester, Mass. Known as the Norton BFR and designed for use on right-angle or sander-type portable grinders, this lightweight wheel is sufficiently flexible to permit blending contours as well as smoothing down welds and notching risers in all kinds of castings.

Made of a carded web material impregnated with sharp aluminum-oxide or silicon-carbide abrasive grains, the BFR's laminated construction with layers of a strong fabric for reinforcement makes for extra strength and built-in safety and practically eliminates the possibility of breakage in operation, says Norton. Should the wheel be accidentally cracked in service, a safety web of nylon molded into the back serves to hold the pieces together until the grinding machine can be stopped.

In addition to blending contours and smoothing down welds, the BFR is being used with success on such jobs as smoothing flame-cut edges; removing rust, scale and mold marks from castings; notching big gates and risers on castings; cutting off gates and risers on brass, bronze and aluminum castings; preparing casting surfaces for painting; and removing burrs and sharp edges on steel plate.

The wheel is supplied in two diameters, 7 and 9 inches, and comes in three thicknesses—⅛, 3/16 and ¼ inch. To properly support it in operation a special backing pad or recessed back flange must be used. Such a pad is included in a kit supplied at nominal cost by Norton for mounting the hub wheel on any standard right angle-head portable grinder or sander.

Interesting Experiment in City Planning

INSPIRED by a British example, the city fathers of Stockholm began a venture in residential planning about two years ago at a point approximately 10 miles west of the Swedish capital. The community, named Vallingby, is to be a garden city with private homes and apartment houses, some as much as twelve stories high, for around 24,000 people and with complete civic, social and trade facilities for the inhabitants as well as those of neighboring areas.

Planned in detail in advance of construction to coördinate all public utilities, Vallingby is being built around a community center facing a 100,000-square-foot plaza and over a subway connecting it with the metropolis. Sixty stores and shops of all kinds and offices with 400,000 square feet of floor space will be located there both below and above street level, and half of the open space will be reserved for pedestrian use and half for vehicular traffic. Work on this part of the project is well underway and many of the dwelling units are already occupied.

With commendable foresight, the authorities are also creating an industrial center about ¾ mile beyond the outskirts of the town. It will cover an area of some 2,000,000 square feet and will be far enough advanced by the middle of this year to employ approximately 1500 persons and twice that number in 1955, or about half of the community's wage earners. Churches, schools, libraries and dental and medical clinics, with two hospitals nearby, are also included.

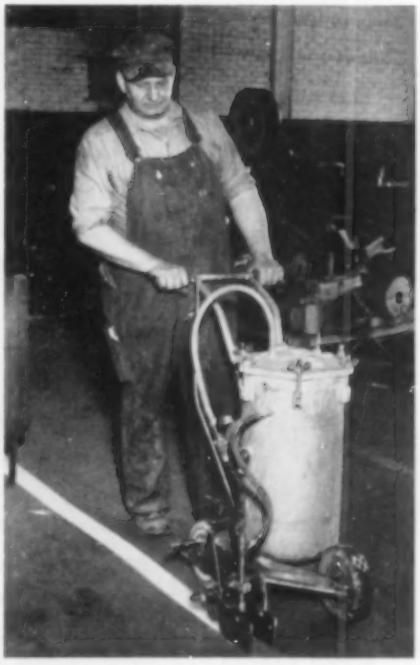
Initially, heat and hot water are to be furnished by a temporary oil-fired boiler installation that can be readily converted to burn other kinds of fuel. Ultimately, however, both will be delivered by a steam plant now being constructed several miles south of the new residential section by the City of Stockholm for its own use during peak-load periods. The surplus is to be delivered to Vallingby and adjoining suburbs through a system of rock-wool insulated pipes run through large culverts. It is estimated that the heat loss between the inlet and outlet points will be around 10°F. In addition, a garbage incinerator will also meet some of the district's hot-water requirements. A feature of this plant is the stoker which reduces to dust any bottles and tin cans that may be in the refuse.

As the terrain on which Vallingby is rising is hilly, it has been possible by means of parkways with overpasses to lay out a network of streets that will permit children to go anywhere without crossing heavily traveled highways. The latter will have separate lanes for bicyclists and will be wide enough for parking. This first large-scale housing experiment in Sweden is scheduled for completion near the end of 1955.

Safety-Line Marker

A SAFETY-LINE marker that may be used by industrial plants, municipalities, etc., either in buildings or out of doors is a new product of the G. N. Spiess Equipment Company. It is composed of a steel tank divided into two sections one of which holds 3 gallons of paint and the other compressed air at 90 to 100 psi. The paint is sprayed through a special brass nozzle confined by shoes or guides to form the line. Shoes are adjustable to obtain a 2- to 4-inch or a 2- to 6-inch stripe depending on the model utilized, and are said to prevent any tendency on the part of the paint to bleed or spread.

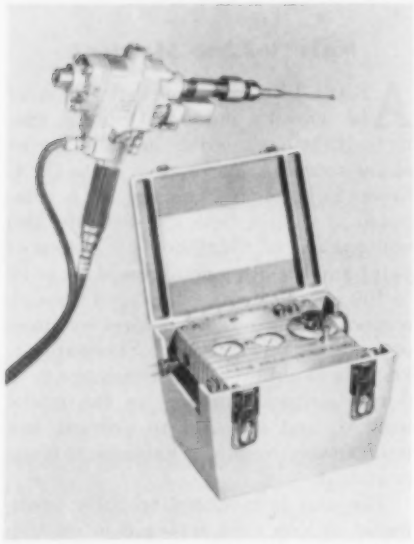
The unit is mounted on three pneumatic balloon tires arranged in relation to the shoes in such a way that lines may be run within one inch of walls, curbs etc. In addition, the operator need not straddle the stripe he is painting. The machine can be charged with air from any convenient source, and one filling of paint and air is sufficient, it is claimed, for 3000 linear feet of 3-inch line. The shoes, hose, spray gun, etc., are all removable for easy cleaning and maintenance. The marker weighs only 150 pounds, is 35 inches high, 24 inches wide and 36 inches long. Hand propelled, it may be used on any hard surface.



Circle IE on reply card

Industrial Notes

Development of a tube-rolling unit that combines the advantages of air operation and electric control has been announced by Crane Packing Company. It is designed to use any one of three air motors of different sizes which, because



of their power and flexibility, quickly roll both ferrous and nonferrous tubing from 1¼ to 2¼ inches in inside diameter on equipment such as condensers, heat exchangers, boilers, evaporators, etc. Electropneumatic operation, it is said, controls the amount of tube expansion so that tightness and holding strength in the sheet are exactly in accordance with service requirements; eliminates "weepers" and the possibility of overrolling; minimizes cold-work crystallization to a negligible degree; and prevents distortion or fracture of ligaments in the tube sheet. The unit shown is equipped with an Ingersoll-Rand Multi-Vane air motor.

Circle 2E on reply card

An easy to install and maintain 2-piece lining for crucible melting furnaces is the latest labor-saving device for foundries. A development of Electro Refractories & Abrasives Corporation, it is shipped on a pallet assembled and ready to go into the furnace. Previously, linings have been installed in a series of circular half-sections, usually only 4½ inches high. The new one consists of but two complete rings, each from 12 to 15 inches high, depending upon the diameter of the furnace.

Circle 3E on reply card

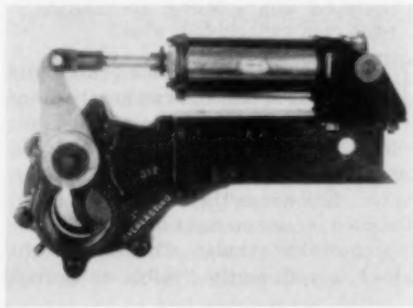
An improved pressurized fire extinguisher of the dry-chemical type has been announced by American-LaFrance-Foamite Corporation. It features a special discharge nozzle that goes into action the instant a pin is pulled and a lever squeezed, fanning the chemical outward in a wide pattern with great density. When partially operated, the unit can be left standing without loss of pressure should a fire reflash before it can be recharged with air or nitrogen at 150 psi. It is provided with a gauge that indicates whether it is in condition for use. There are four sizes of the new hand extinguisher.

Circle 4E on reply card

Motorists who buy batteries oftener than is necessary because they fail to check the water content regularly should appreciate a new device called the Hydrocap. This replacement of the ordinary cell cap is a miniature chemical plant. It catches oxygen and hydrogen as they are released by the battery and then, with the help of a palladium-coated catalyst, reunites them to form water. As the droplets trickle back into the battery they absorb escaping sulphuric acid fumes that would otherwise corrode terminals and cables. Industrial Research, Inc., which makes the Hydrocap, claims that a battery so equipped will go seven times the usual period before requiring more water.

Circle 5E on reply card

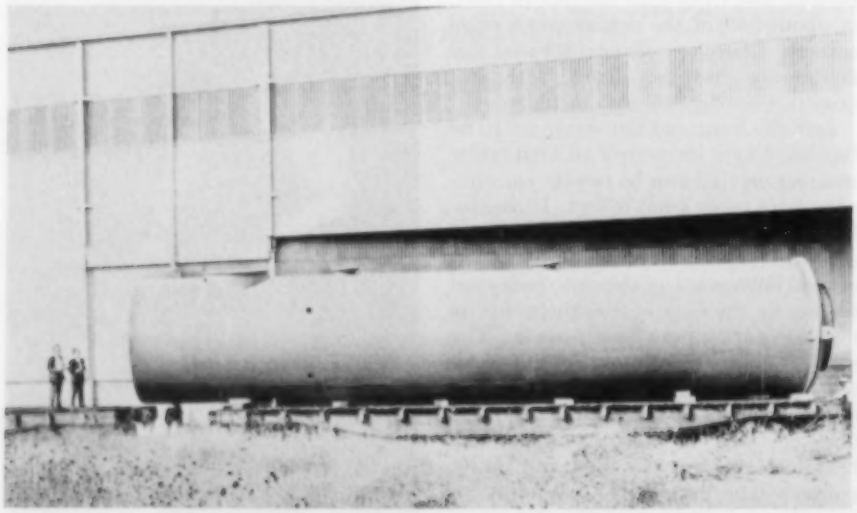
For more accurate control of process work and to permit automatic cycle operation, Everlasting Valve Company now has available cylinder-operated gate valves of the sliding type. The valve itself is of standard construction with a straight-flow passage and all interior working parts moving between parallel



faces without any damaging wedging action. The assembly, as the accompanying picture shows, is simple and compact. One end of the cylinder is pivoted to a bracket cast on the valve body, while the end of the piston rod is attached to the lever that controls the valve. Air not exceeding 150 psi is used and varies with the size of the valve which, in turn, determines the size of the cylinder. The latter may be manually, electrically or remote controlled and actuated by air or hydraulic power. Unless otherwise specified, the unit is provided with a Bellows pneumatic cylinder that has a built-in control valve and requires only one air connection.

Circle 6E on reply card

With air at 100 psi, Alliance Manufacturing Company's new combination air-oil bench press is said to exert a pressure of 5 tons for such operations as staking, broaching, riveting, forming, crimping, trimming, flanging, etc. Named Pnu-draulic, the machine differs from mechanical punch presses in that the work is done under preset pressure instead of a downward stroke to a fixed position. The ram is lowered and raised under low pressure, and high pressure comes into play only to perform the



GRANDADDY OF THEM ALL

The cylindrical unit pictured is believed to be the biggest snubber or silencer ever built. It is 74 feet long, 12 feet in diameter and weighs about 35 tons. Because of its great size it had to be transported in three sections. It was designed and constructed by Burgess-Manning Company for silencing the exhaust of a 5000-kw gas turbogenerating unit installed in a midwestern utility plant.

operation. Nor does booster pressure kick in until the workpiece is positioned accurately, thus reducing breakage of dies and parts to a minimum. Operator safety is insured by a 2-handed press trip. The machine is equipped with an automatic timer for cycle control and dwell period at the bottom of the stroke, which is adjustable from 3 inches to zero. It can be attached to a shop air line and consumes approximately ¼ cfm per stroke.

Circle 7E on reply card

Putting a problem "on ice" had excellent results recently when L. H. Lingerfelt, Department of Sanitary Districts engineer, was confronted with the task of lowering some hundred feet of live water main to permit street leveling operations in Henrico County, Virginia. It was feared that the conventional rope-sling method, with its attendant unequal distribution of weight, would lead to pipe breakage and disruption of service. When excavating was completed, the wooden blocks used to support the main while that work was in progress were replaced by 50- and 100-pound chunks of ice which, as it melted, lowered the pipe to the desired level at the rate of about 4 inches per hour.

Circle 8E on reply card

For control circuits requiring a time delay initiated by a momentary impulse induced by a microswitch or push button, for example, Elastic Stop Nut Corporation of America has added a new unit to its Agastat line—the Type NEH—that has an adjustable range from 0.1 second to 10 minutes and more. The length of the delay is controlled by a flow of air through an orifice and by a needle valve that is set by a screw on top of the timing chamber and that varies the size of the orifice. The air used is recirculated within the chamber to keep it clean. The NEH has an auxiliary switch that functions at the end of the time delay. The contacts are held open in the deënergized state and close as soon as the circuit is closed to energize and keep the Agastat coil energized.

Circle 9E on reply card

Compressed-air systems can, it is claimed, be automatically drained of condensation in the course of closing down at night or between shifts by means of a unit designed by Wilkerson Corporation. It begins to function when the pressure in air pipes, aftercoolers, etc., drops just below 10 psi and blows out all moisture before the line pressure reaches zero. Conversely, when pressure builds up again, the apparatus closes or resets as soon as it exceeds 10 psi, which is the standard operating pressure. However, the drain can be designed to do its work at lower or higher pressures.

Circle 10E on reply card

Leak-Tec is a sensitive liquid offered by American Gas & Chemicals, Inc., for detecting gas or air leaks so minute that it is difficult to locate them by ordinary means. Noninflammable and noninjurious to the user, it is squirted from a plastic bottle onto surfaces and around pipe joints, penetrating rust scales and cracks and creating tell-tale bubbles at points of leakage. The special formula is being used successfully by maintenance crews for testing gas installations, gas-filled electric cables and transformers, refrigerating equipment and air conditioning systems, as well as for inspecting finished products and delicate instruments on assembly lines. Samples are furnished upon request.

Circle 11E on reply card

Metals of all kinds, even the hardest tempered or case-hardened steel, can be permanently marked, it is claimed, with a new electric pen developed by Newage International, Inc., and called the Actograph. Regular current reduced to 2-7 volts by a special transformer is used,

and a built-in magnetic vibrating system with a writing point at the terminal produces a short continuous arc that enables the operator, by means of a screw adjustment, to scribe thin or thick lines and to adjust their depth. The

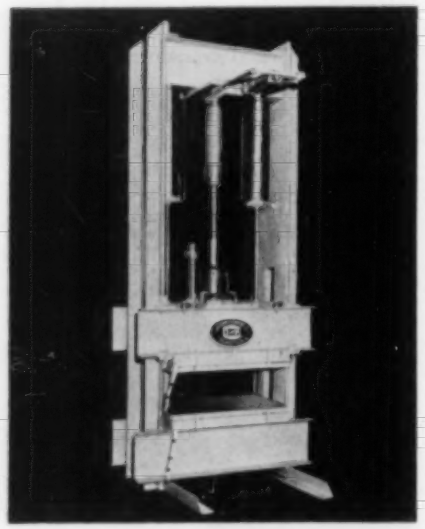
FOR BETTER EXPOSURE

Sand blasting and spray painting large assemblies at the Torrance, Calif., plant of National Supply Company is made easy with a new fixture called the manipulator. It is shown here holding a frame for an oil-well drilling rig while it is being cleaned with an aluminum-oxide abrasive applied with a Vacu-Blaster unit which embodies a dust collector. Thus mounted, the workpiece can be rotated all the way around to expose every part of it. Built in two sections, the manipulator is moved to various working areas as required. Until the new rig was available, big pieces were often cleaned with wire brushes and acid. Compared with this procedure, the new arrangement does the job 40 percent quicker.

point is made from a special material and can be resharpened by grinding or with a smooth file.

Circle 12E on reply card

For molding reinforced plastic, Davidson-Kennedy Company, in coöperation with Gladwin Plastics Company, has developed a press that can be provided



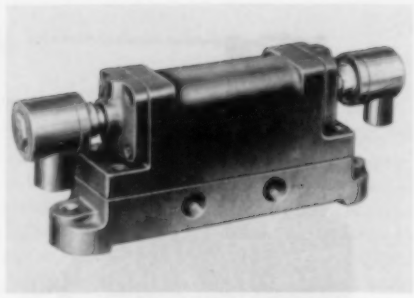
in a wide variety of stroke, pressure and daylight-opening combinations to meet specific requirements. Of the low pressure type, 90 percent of the paten or die travel is effected by means of an air cylinder, and a self-contained hydraulic unit furnishes power for the pressure stroke. The machine is fabricated from stress-relieved structural steel and easily movable. It is ready for operation when tied in with a shop air line and an electric circuit. The manufacturer says that simplicity of design makes it possible to market the press at comparatively low cost.

Circle 13E on reply card

A 150 hp 4-wheel tractor recently introduced by Caterpillar Tractor Company has two air-operated devices. Application of the foot-controlled wheel brakes is assisted by pneumatic boosters, those on the pulled unit being actuated an instant before those on the tractor. This prevents "jacknifing." The flywheel clutch also has a compressed-air booster that reduces the pressure the operator has to exert when engaging and disengaging the dual 16-inch clutch plates. The new tractor has ten forward and two reverse speeds.

Circle 14E on reply card

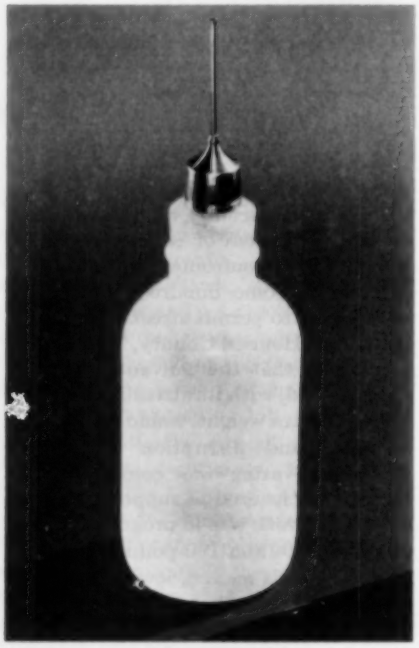
To its line of Nopak air-control valves Galland-Henning Manufacturing Company has added a series of pilot-operated 4-way slide valves of all aluminum construction. The Model "V," as it is designated, is available in two types: a reciprocating and an air-return valve. In the case of the former, the slide valve is linked to a balanced piston, and exhaust-



ing air from either end of the piston by a 2-way bleeder valve causes pressure on the opposite end to shift the valve. The slide valve of the Type "AR" is linked to an unbalanced piston which is shifted by admitting compressed air to the larger end by energizing a 3-way normally closed solenoid pilot valve. The units are available in varying pipe sizes and have a wide range of control applications.

Circle 15E on reply card

Under the trade name Silent Sentry, R. G. Genzlinger, Inc., is offering a sensitive device that can be used to start and stop electrically driven machinery, turn lights on and off, sound alarms and perform many other jobs. Though it is



HYPODERMIC OILERS

For dispensing minute quantities of lubricating oil or other liquids and especially for reaching hard-of-access places, Gaunt Industries offers hypodermic oilers in two sizes. The reservoir in each case is a 2-ounce polyethylene bottle of the rubberlike squeeze type in which the fluid level is visible at all times. The difference between them is in the size of the opening in the 1-inch-long hollow needle. That in the one intended for applying any light lubricant or liquid is 0.025 inch in size; the other, for handling heavier oils and solvents, light glues and cements, has a 0.049-inch bore.

Circle 16E on reply card

Sauerman installations provide economical handling of a wide variety of bulk materials, from bauxite to zinc ore . . . at rates ranging from 10 to 800 cu. yds. per hr. Storage areas range from a small bin to ten acres or more.

Quick change from stockpiling to reclaiming is accomplished by unclamping and re-attaching the operating cables so as to turn the bucket around when the power is applied. Non-caving or free-flowing materials are handled with equal efficiency.

The operator can be located in a safe cab overlooking the work area. Many Sauerman installations are remotely operated through air or hydraulic controls.

Let Sauerman engineers show you how to use your storage area to its fullest extent. Send for Catalog E, *Bulk Storage by Power Scraper* and 32 *Tested Methods For Handling Bulk Materials.* Request the following Field Reports:

FR-224 Handling Ore with Drag Scrapers
FR-104 African Storage of Iron Ores

SAUERMAN BROS., Inc.
548 S. Clinton St., Chicago 7, Illinois

Circle 19A on reply card

not a photoelectric cell, approach of an individual, not physical contact, causes it to function, and sensitivity can be adjusted to meet requirements. Installed on a machine, the unit will protect the operator by shutting it down should any part of his body come dangerously close to the working parts. It can also be set to take photographs of persons entering prohibited areas, says the manufacturer.

Circle 17E on reply card

In its recently announced Type FS intake air filter for compressors and small portable or stationary engines, American Air Filter Company, Inc., uses an accordion pleated galvanized wire screen covered with rayon flock. The latter is bonded to the 14-mesh screen with a thermoplastic compound that is imper-

vious to gasoline and other solvents. The filter may be operated either dry or coated with oil with little difference in cleaning efficiency. An inner perforated screen baffle serves to equalize the air flow and to protect against backfire. A weather shield is available for outdoor installations. The Type FS is made in a capacity range from 50 to 800 cfm.

Circle 18E on reply card

Custom-built fume-washing towers seem to have a competitor in a compact, portable unit called the Cyclonaire. Developed by The U.S. Stoneware Company, it takes little time to set up and is ready for use when connected to a water main of adequate capacity. From bottom to top it is made up essentially of a liquor drain pipe, gas intake duct, one or more sections containing special packing, water inlet and spray-type distributor, drive motor and exhaust fan and duct. There are two standard sizes: a 20-inch unit 8 feet 5 inches high and a 30-inch tower 9 feet 7 inches tall. They have a rated capacity of 750 and 1650 cfm of air, respectively. This can be increased by connecting two or more washers in parallel. Though designed primarily to handle noxious or corrosive fumes, the Cyclonaire is suitable for removing irritating dusts.

Circle 19E on reply card

WATER...
WHEN AND WHERE
YOU WANT IT

Naylor pipe and Naylor Wedge-Lock couplings provide the perfect combination that makes it easy for you to put water wherever you need it in mining operations. Naylor's lockseam-spiralwelded structure creates a light-weight pipe that is easy to handle and install, yet extra strong for the heavy-duty service required. The one-piece Wedge-Lock couplings provide the fastest and simplest method of pipe connection available today.

For the full story on this Naylor combination, ask for Bulletins No. 507 and No. 513.

NAYLOR PIPE

Naylor Pipe Company • 1245 East 92nd Street, Chicago 19, Illinois
Eastern U.S. and Foreign Sales Office: 350 Madison Avenue, New York 17, New York

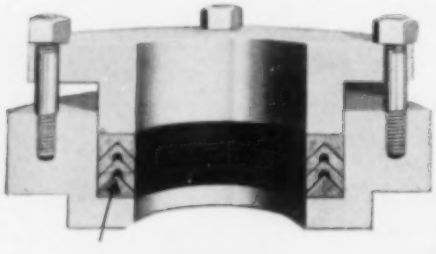
Circle 20A on reply card

Why users prefer

CHEVRON* Packing

for rams, plungers, reciprocating rods

1. *Assures a low friction, positive seal*
2. *Lasts much longer, needs less maintenance than ordinary V-type packing*
3. *Works efficiently in a shallow stuffing box*



Note the exclusive hinge-like construction of CHEVRON packing.

Garlock 431 CHEVRON Packing

GARLOCK CHEVRON Packing is entirely different from ordinary V-type packings. With *increasing* pressures CHEVRON rings tighten and prevent leakage; with *decreasing* pressures the packing eases off and permits operation with a minimum of friction.

Service reports, such as those below, prove that CHEVRON packing seals better and lasts longer.

- On hydraulic press—40″ ram, 6,000 p.s.i., ram honed and chrome plated, gland machined to give clearance of .006″ between gland and ram. Garlock 431 CHEVRON size 40″ x 41½″ x only 2″ deep gave 14 years service.
- On a machine with hydraulically operated clutches—¾″ cylinder, maximum pressure 500 p.s.i., service intermittent, maximum travel ¾″. First used cups, then "O" rings, neither of which worked well. Now packed with Garlock 431 CHEVRON ⅜″ x ¾″ x 13/32″ deep and doing a smooth, positive sealing job.

Ask your Garlock representative to give you all the cost-saving facts about CHEVRON packing, or write for folder AD-115.

THE GARLOCK PACKING COMPANY, PALMYRA, NEW YORK

Sales Offices and Warehouses: Baltimore • Birmingham • Boston • Buffalo • Chicago • Cincinnati • Cleveland Denver • Detroit • Houston • Los Angeles • New Orleans • New York City • Palmyra (N.Y.) • Philadelphia Pittsburgh • Portland (Ore.) • Salt Lake City • San Francisco • St. Louis • Seattle • Spokane • Tulsa.

In Canada: The Garlock Packing Company of Canada Ltd., Toronto, Ont.

*Registered Trademark

GARLOCK

PACKINGS, GASKETS, OIL SEALS, MECHANICAL SEALS

RUBBER EXPANSION JOINTS

Circle 21A on reply card

QUOTES

—FROM HERE AND THERE

Safety Air Ejector

"Despite goggles, dirt and chips may injure eyes when holes drilled in metal are blown clean. A recent invention 'vacuums' the dirt and prevents it from flying. The jet that forces air into a hole is surrounded by a tube that fits closely against the part to be cleaned and expands into a chamber with an exhaust air screen. Cleaned-out dirt collects in the chamber for disposal."

Science and Appliance, February, 1954

Inner Tube Cushioned with Latex Compound

"Gum-filled inner tubes and the tubeless tires that seal themselves after a penetrating object has been pulled out are improvements that seem long overdue in a world on rubber. A latex compound, said to turn an ordinary inner tube into a safer one if squeezed through the air valve, is available. It seems to be similar to the dope that made 'puncture-proof' tires in bicycling days."

Science and Appliance, February, 1954

Rings are Occupational Hazard

"Convair, Forth Worth, has begun a drive to see that sentiment does not interfere with safety. It has now warned employees to remove rings and bracelets before they start to work, because two employees lost fingers in as many months because they were wearing rings. Commonest cause is catching of rings when workers are letting themselves down from an elevation—leaping from work stands, for example. Another frequent cause is catching of a ring in machinery."

American Machinist, February 15

It Pays to Grease Presses with a Pressure Gun

Included among better maintenance and safety equipment introduced in the Eureka Specialty Printing Company shop as the result of work-simplification study is a pneumatic gun for greasing the big presses. It replaces a 3-pound hand-held unit and takes power from the air line running to each press. The gun which "screws right into the opening of a 25- or 50-pound pail of grease . . . can be moved on two wheels from press to press. To operate it, the pressman needs only to connect the compressed-air coupling, and grease is pumped by the gun directly from the pail. Greasing the four-color press is now done in one-tenth the time. Also, the presses are being greased fully . . . . This did not always happen with the hand gun."

The Inland Printer, February, 1954

Books and Industrial Literature

A how-to-do-it book on earth moving that rings the bell has been written by Herbert L. Nichols, Jr., a Connecticut contractor who specializes in excavating and grading. Titled *How to Operate Excavation Equipment*, the work reflects the author's expressed purpose "to help the men and machines that move the earth and to instruct and entertain those who like to watch them do it." The down-to-earth book takes up various types of equipment one by one, explains what they are, what they do, and how they do it. Sprinkled liberally through the pages are simple explanatory drawings. Helpful though his own experience was to him, Mr. Nichols didn't rely on it alone for his information. In an effort to be both accurate and practical, he consulted manufacturers, contractors, engineers and equipment operators. Then he did the layman a good turn by reducing his descriptions to nontechnical language. The book, which is announced as the first of a series, may be obtained from the publisher, North Castle Books, 212 Bedford Road, Greenwich, Conn., or from the Book Department of this magazine. Single-copy prices are $1.50, paper cover; $2.50, library edition; and $3 de luxe field edition. Prices on quantities are quoted by the publisher.

Bulletin No. 800 prepared by the Air and Hydraulic Division of Lindberg Engineering Company describes its standard line of heavy-duty air and hydraulic cylinders as well as large custom-built units.

Circle 20E on reply card

Construction, function and applications of the Hydryer, a packaged unit for the removal of moisture from compressed air or other gases, are covered in Bulletin No. 16.0.081 obtainable from J. F. Pritchard & Company.

Circle 21E on reply card

Chemical Porcelain is the name of Bulletin CP-50 issued by The U. S. Stoneware Company to acquaint industry with its line of pipes, fittings, spacers, valves, joints, flanges, sight glasses, ejectors and packing.

Circle 22E on reply card

A condensed catalogue describing the Wyco line of flexible shafts and allied machines and equipment has been issued by Wyzenbeek & Staff, Inc. Catalogue No. 54 also gives instructions on how to order shafts for specific applications.

Circle 23E on reply card

Sprague Engineering & Sales Corporation has issued a leaflet on its S-214 series automatic shutoff valve for overload protection of gauges and instruments in hydraulic and pneumatic systems. Sizes are available for a pressure range of 10 to 5000 psi.

Circle 24E on reply card

Norton Company has revised its manual on cut-off wheels and is now distributing it without charge. The 36-page illustrated booklet also gives information on various types of cutting-off machines, on the selection, application and proper usage of cut-off wheels, and contains much new data.

Circle 25E on reply card

A new collet and chuck bulletin—No. 100E—with all data and specifications grouped conveniently for quick reference, has been announced by Rivett Lathe & Grinder, Inc. It emphasizes the fact that precision work depends not only on the machine but also on the method of mounting it.

Circle 26E on reply card

Bulletin No. 61861 published by Pantex Manufacturing Corporation describes and illustrates its recently introduced wobble-rod air valve which is said to represent a new approach to on-off control of pneumatic circuits. The book tells how the valve works and gives applications clarified by drawings.

Circle 27E on reply card

Uneepac, a Johns-Manville packing especially suitable for compressors, hydraulic presses, accumulators, pump rods and plungers and similar installations is illustrated and described in an available folder. It is made up of sets of endless or split rings each of which centers itself on the preceding one to provide a maximum of sealing efficiency in a minimum of space. The brochure lists the number of rings that should be assembled for a given pressure range and gives pertinent data of aid to machine designers.

Circle 28E on reply card

Information on more than 30,000 types and sizes of metal and fiber washers is contained in a pamphlet available from H.K. Metal Craft Company.

Circle 29E on reply card

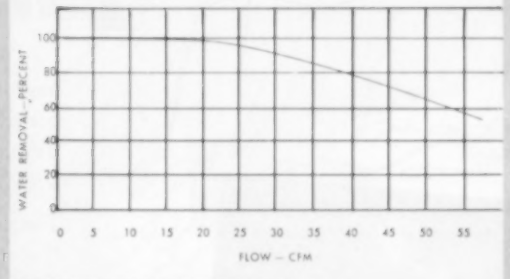
Complete Sash Maintenance published by The Tremco Manufacturing Company appears to be a handy book for the maintenance man. It explores the entire field of calking and glazing, rust prevention and sash and masonry restoration based on 25 years of experience.

Circle 30E on reply card

PERFORMANCE DATA PROVE

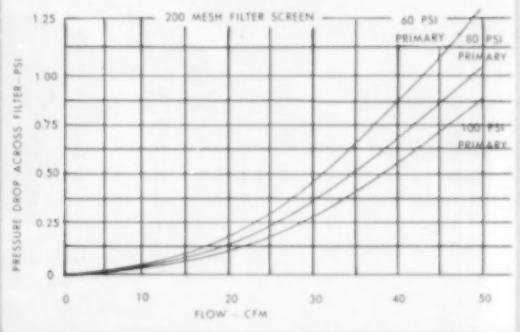
Norgren Automatic-Drain Filter's

HIGH EFFICIENCY IN MOISTURE REMOVAL



operates whether air pressure is constant or fluctuating, whether or not air is flowing.

LOW PRESSURE DROP



Filtering the air that powers your tools, cylinders and other pneumatic equipment is essential if you want better equipment performance and more output with lowest maintenance costs.

The new transparent bowl Norgren Automatic-Drain Filter gives you this vital protection automatically, whether air pressure is constant or fluctuating, whether or not air is flowing . . . assures clean, dry air under all conditions, without attention. Flow: 0 to 35 cfm; pressure: 30 to 150 psi; temperature: 40° to 120° F.

Drain operates automatically, but discharges only under full load to reduce wear and loss of air.

WRITE FOR NEW CATALOG No. 600

C. A. Norgren® CO.
3407 So. Elati, Englewood, Colo.

PIONEER AND LEADER IN OIL-FOG LUBRICATION FOR 26 YEARS

Valves • Filters • Regulators • Lubricators • Hose Assemblies

Circle 22A on reply card

186,072,500

pounds of Tube-Ice

used in building

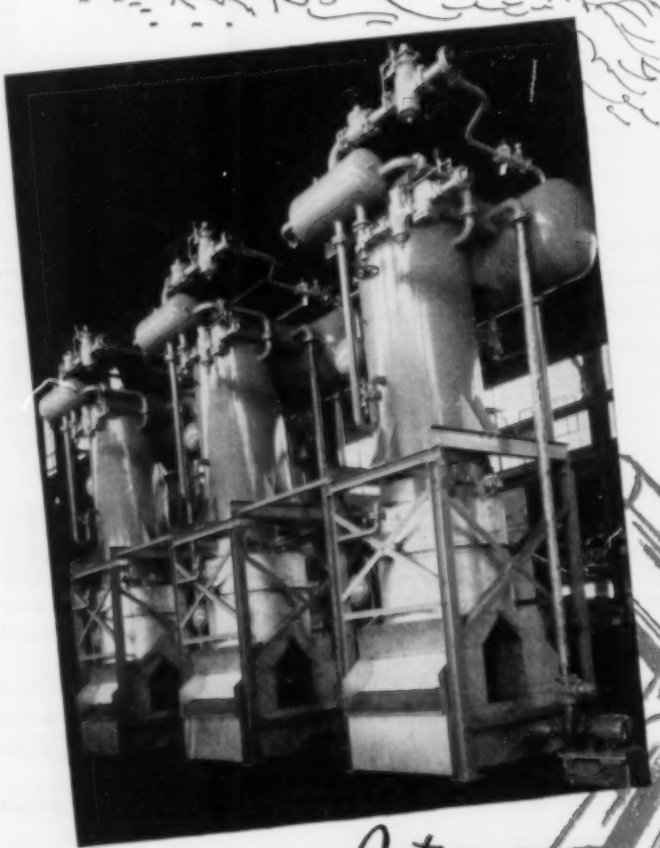
2 WESTERN DAMS*

Yes—that much ice was required to cool the concrete mix in order that it set properly to develop its ultimate strength for two outstanding dam structures.

The important part of this message to you is that the compact and readily portable Vogt Tube-Ice Machines pictured here set this record without even the replacement of a freezer tube. What's more, they are *ready to go again* whenever ice is needed in quantity.

Tube-Ice is widely used in process work and for preserving shipments of meat, fish, milk or vegetables . . . and is produced at the lowest possible cost per ton since a Tube-Ice unit occupies less space, has fewer parts, uses less power than any other method for making ice.

Tube-Ice Machines are available in sizes from 2000 lbs. per day up to any desired capacity. Send for free Bulletin TI-3.



**McNary Dam, Washington, and Pine Flats Dam, California, required a total of 2,730,000 cu. yds. of ice cooled concrete mix.*

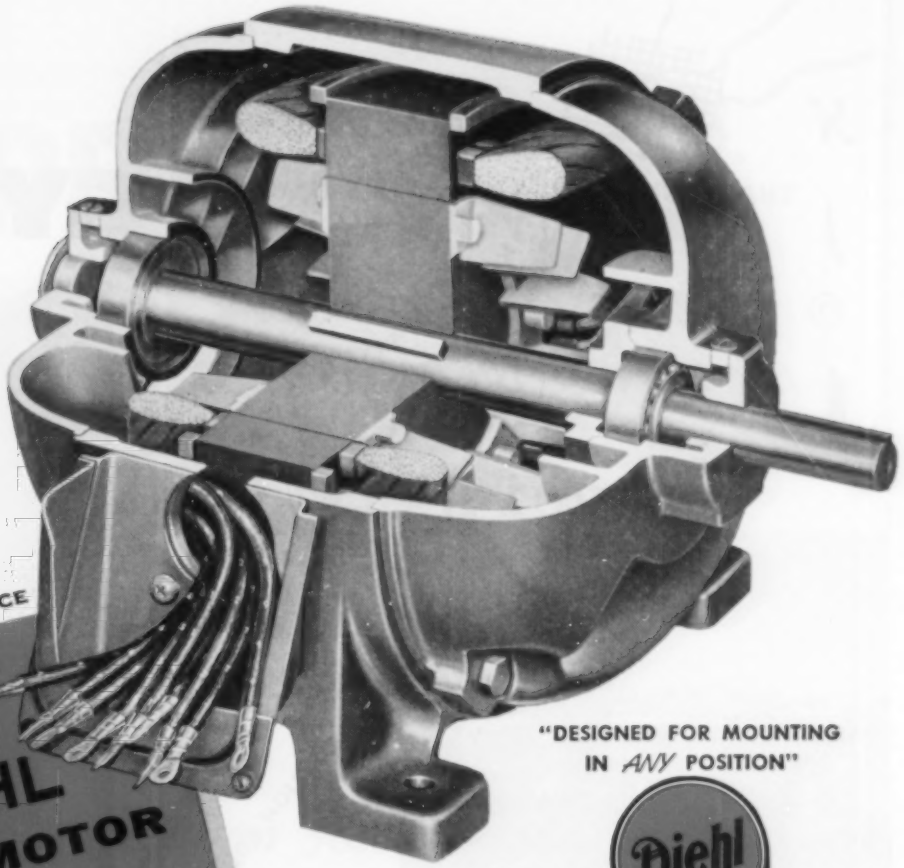
HENRY VOGT MACHINE CO.
LOUISVILLE 10, KENTUCKY

BRANCH OFFICES
New York, Philadelphia, Chicago, Cleveland, St. Louis, Dallas, Charleston, W. Va.

Automatic

Vogt TUBE-ICE MACHINE

Circle 23A on reply card



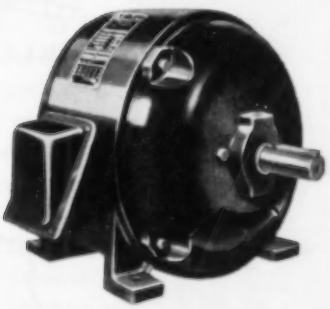
TOPS IN QUALITY
COMPETITIVE IN PRICE

SPECIFY THE New DIEHL TYPE "D" MOTOR

"DESIGNED FOR MOUNTING IN *ANY* POSITION"

Diehl

...here's 12 reasons why



- Most Advanced Slot Insulation
- Machine Fitted Stator
- Rotor Keyed to Shaft
- New High Dielectric Insulated Stator Windings
- Permanently Numbered Leads
- Conduit Box, An Electrician's Delight
- Centrifugally Cast, High Density Rotor Windings
- Rugged Stress-Relieved End-Covers
- New Pre-lubricated Heavy Duty Ball Bearings
- Locked-in Ball Bearing
- Dual Ventilation System
- Extra Strong Cast Iron Frame

Designed and engineered for more efficient performance. Smaller in size, lighter in weight and quieter in operation.

Consult our engineers before writing your specifications and get the benefit of 68 years of experience in the design and manufacture of general and special purpose motors

Diehl motors will still be available in old NEMA Standard frame sizes for interchange and replacement.

DIEHL MANUFACTURING COMPANY
Electrical Division of THE SINGER MANUFACTURING COMPANY
Finderne Plant, SOMERVILLE, N. J.

Please send me the following bulletins

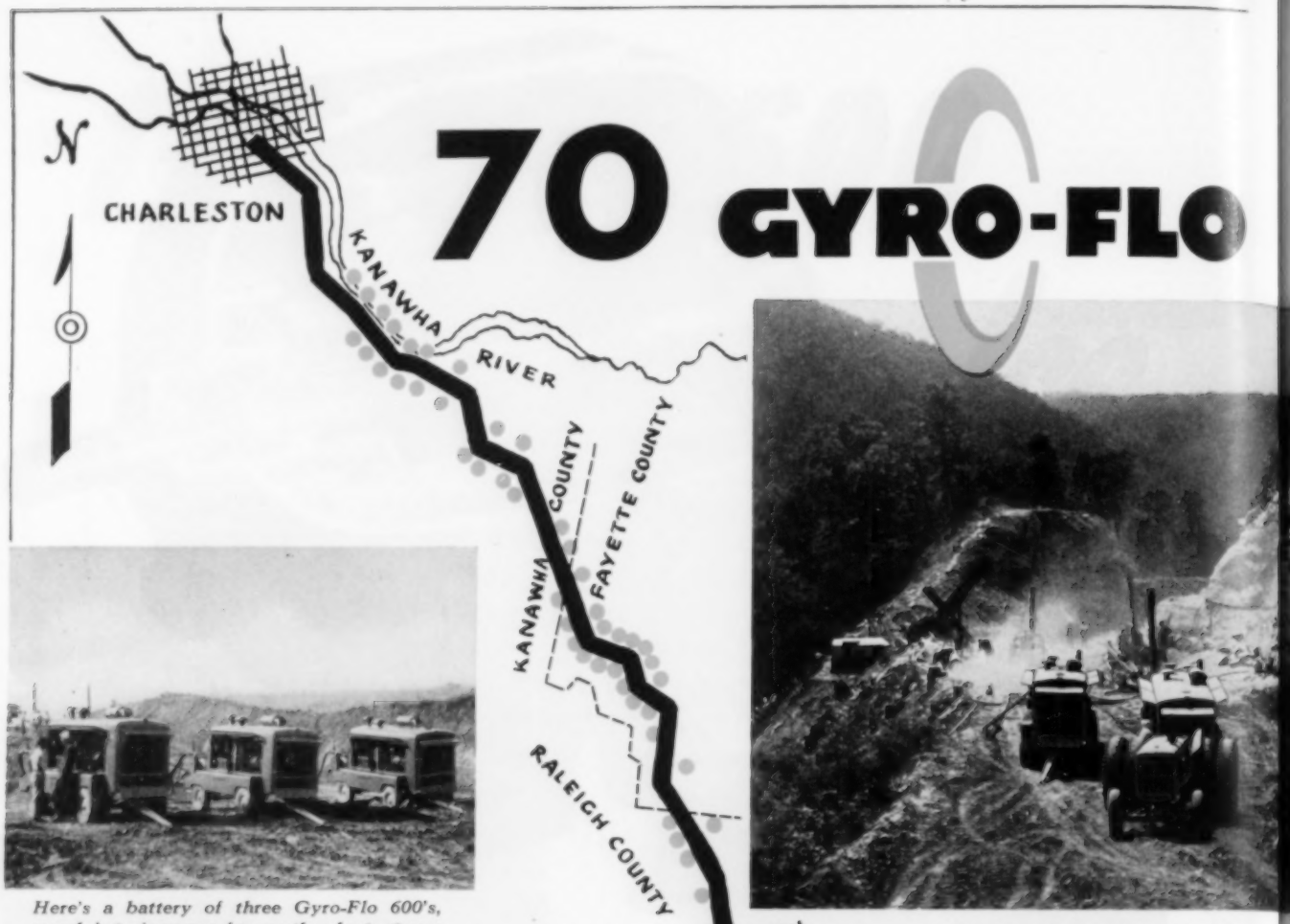
☐ New Type "D" Motor Bulletin No. CA 3304
☐ Consolidated Catalog & Price List No. CA 3310

Name_____
Company_____
Street_____
City_____ State_____

INTEGRAL AND FRACTIONAL HORSEPOWER MOTORS ARE AVAILABLE IN A WIDE RANGE OF TYPES AND SIZES

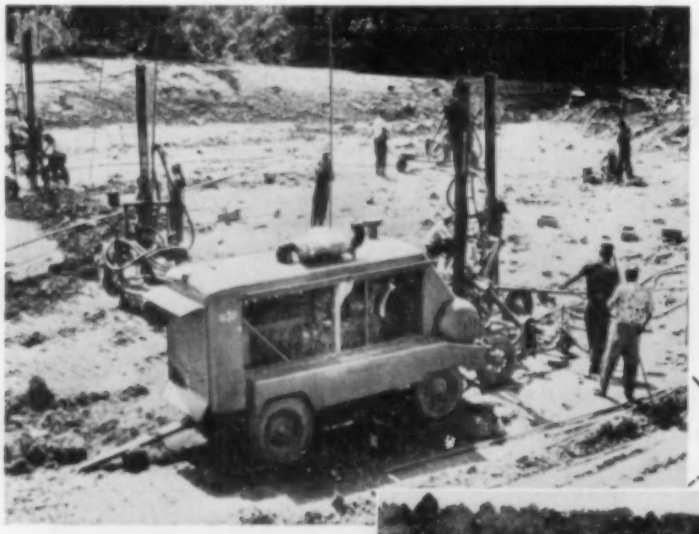
Circle 24A on reply card

70 GYRO-FLO



Here's a battery of three Gyro-Flo 600's, supplying air power for another large group of Wagon Drills.

These two Gyro-Flo 600's are powering a gang of Wagon Drills, on one of the West Virginia Turnpike's largest through cuts — involving removal of 250,000 cu. yd. of rock.



Here's another Gyro-Flo rotary air power plant, supplying a group of I-R FM-3 Wagon Drills on the West Virginia Turnpike, where approximately $2 million worth of rock drilling equipment is in service.

These four Gyro-Flo 600's are manifolded together, providing ample combined power to run as many as ten heavy-duty Wagon Drills.

COMPRESSORS

speed construction of 88 mile expressway through rugged West Virginia mountains

Ingersoll-Rand Rotary Compressors generate more than 38,000 cfm of air power on West Virginia Turnpike

Every red dot on this map of the West Virginia Turnpike represents an Ingersoll-Rand Gyro-Flo Compressor. Added together, they have a combined capacity of 38,880 cubic feet of air per minute. That's a mighty large share of the air power required for this huge drilling and blasting job.

There's a good reason for this overwhelming preference, too. The terrain is extremely rugged and mountainous. Many of the drilling sites are difficult of access. And service facilities for major repairs are comparatively remote. Hence *dependability* in heavy-duty service is of paramount importance.

In conditions such as these, the advantages of the Gyro-Flo rotary compressor are well demonstrated. For this has proved to be the most maintenance-free portable compressor ever developed. There are no pistons, rings, rods, valves or clutches to wear out, adjust or replace. Eighty per cent *fewer wearing parts* means correspondingly greater simplicity of operation and maintenance. What's more, Gyro-Flo compressors deliver a smooth, pulsation-free output of cooler, oil-free air at pressures that are automatically maintained between 100 and 110 psi under all load conditions.

Now available in 125, 210, 315 and 600 cfm sizes, there's a Gyro-Flo portable that's *right* for practically any construction job. Why not take advantage of their improved performance on *your* next drilling project. Your nearest I-R distributor or branch office will be glad to give you complete information on all sizes. Call him today —or write to Ingersoll-Rand for your copy of Bulletin No. 2321.

IR CONTRACTORS' COMBINATION

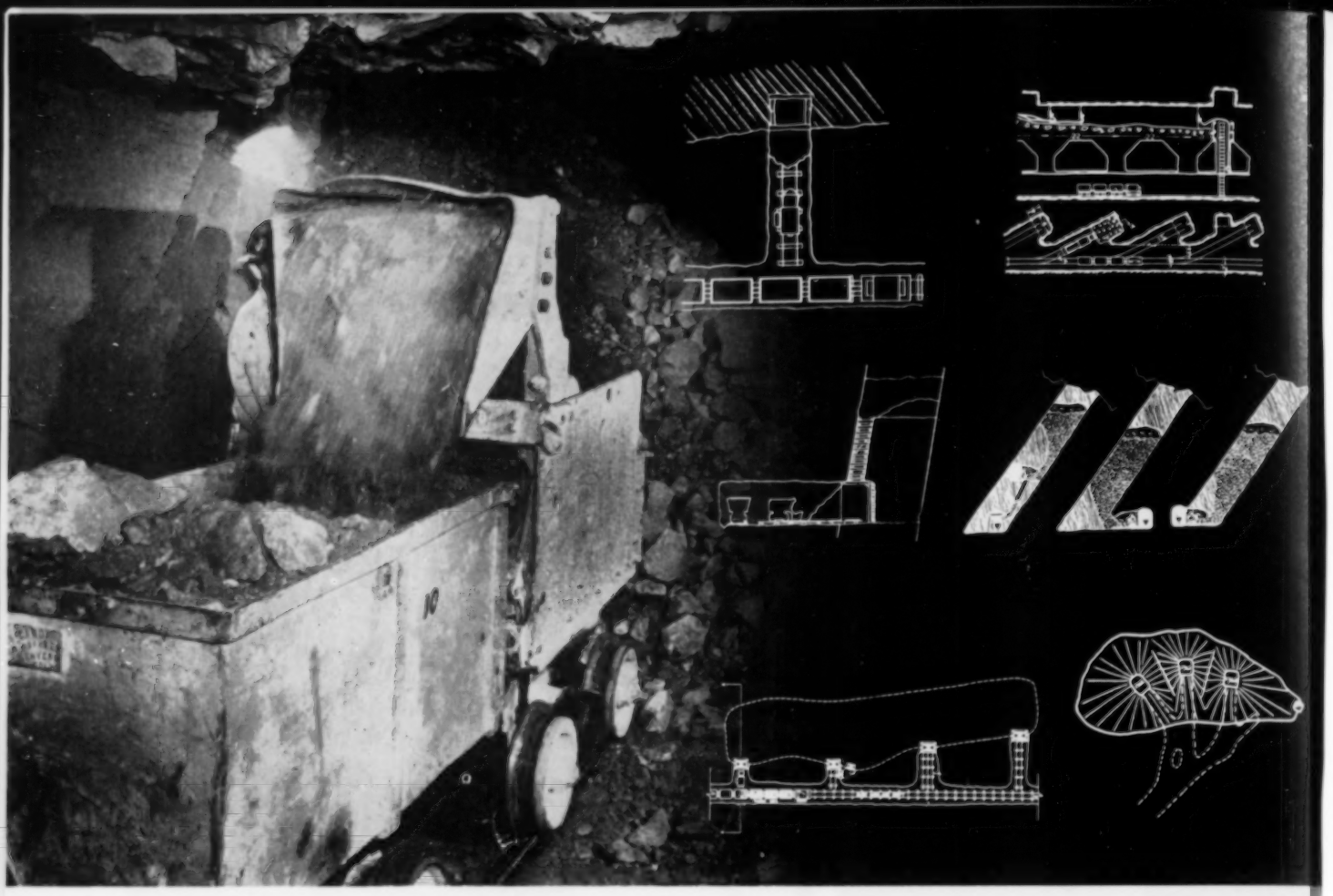
COMPRESSORS
ROCK DRILLS
AIR TOOLS
CARSET BITS
PUMPS

Ingersoll-Rand

11 BROADWAY, NEW YORK 4, N. Y.

2-35

Circle 25A on reply card



GREATER PRODUCTION PER MAN SHIFT TO COMPETE WITH METAL PRICES!

HIGH DISCHARGE EIMCO 105

The 105 with the high discharge loading attachment will load into cars over 11 feet high above the rail.

Write for more information on this modern tractor excavator with independent track control, torque converter, oscillating tracks (with loader attached), shifting without stopping and many other exclusive features.

Your mining system can, in many cases, be changed to one of the systems now in use which go by the general name of "drawpoint loading."

Hundreds of mining companies are on our mailing list to receive the latest information we can find on ideas in all parts of the world that will cut mining costs. Many of these companies have changed their systems of mining in recent years to one of the drawpoint systems or have developed a system of their own that would apply. In every case, the mines using Eimco loaders in production drawpoints, have shown savings that make for substantial cost reductions.

Write on your letterhead to be included in this mailing or for information on Eimco loaders in production loading, to The Eimco Corporation, P. O. Box 300, Salt Lake City, Utah.

THE EIMCO CORPORATION
Salt Lake City, Utah, U.S.A.
Export Office, Eimco Bldg., 52 South St., New York City

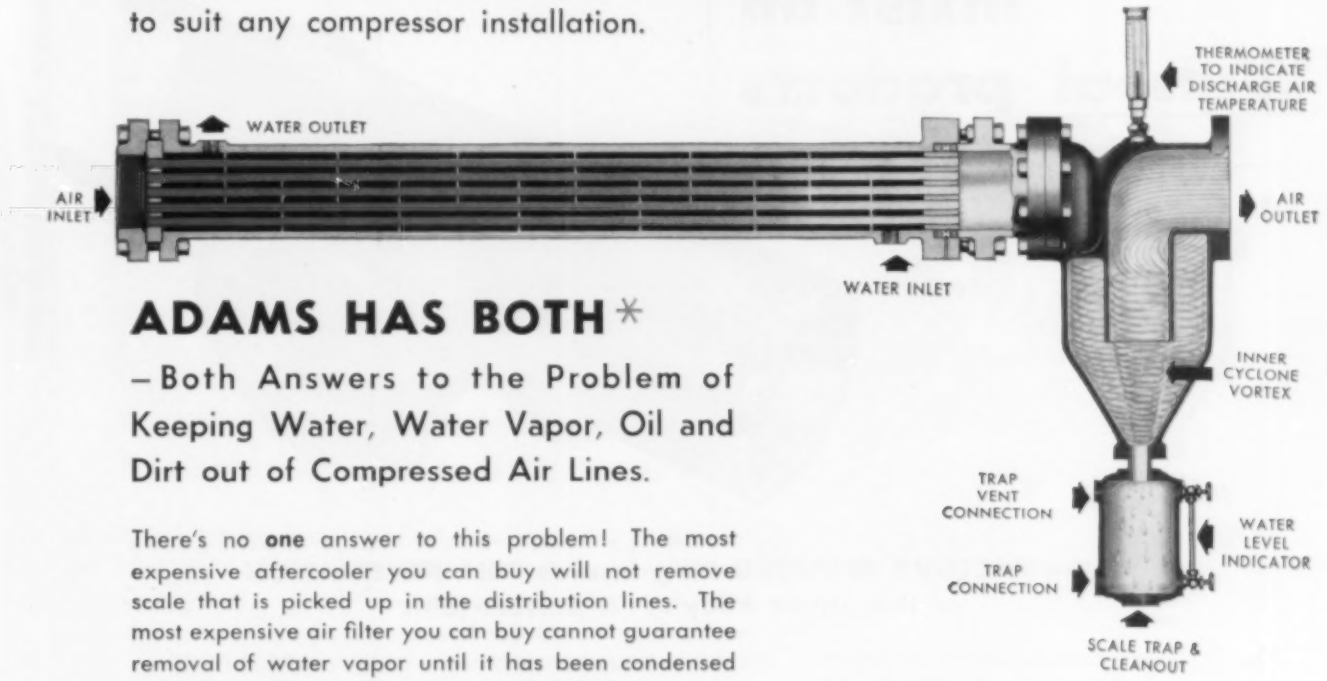
You can't beat an Eimco!

LOSING MONEY ON WET, DIRTY AIR?

Rx SEE A SPECIALIST!

ADAMS Aftercoolers are specially designed equipment with prices and delivery that are standardized to save.

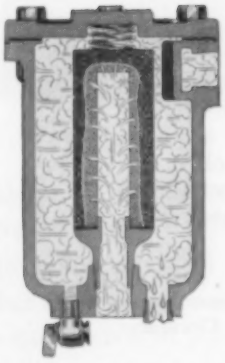
Select your aftercooler, either for a new installation or a replacement, strictly on its merits and you will choose Adams. Specifications to suit any compressor installation.



ADAMS HAS BOTH*

– Both Answers to the Problem of Keeping Water, Water Vapor, Oil and Dirt out of Compressed Air Lines.

There's no **one** answer to this problem! The most expensive aftercooler you can buy will not remove scale that is picked up in the distribution lines. The most expensive air filter you can buy cannot guarantee removal of water vapor until it has been condensed by cooling. That's why Adams makes both.



*PORO-STONE AIR FILTER

1. Centrifugal separation of dirt and liquids.
2. Drainage to trap directed by vertical cast-in slots.
3. Continuous, fully automatic trap action.
4. Rapid diffusion and filtration through permanent, cleanable Poro-Stone.
5. Clean, dry air at practically unchanged pressure. Standard, stocked sizes handle from 10 to 700 cfm.
6. Easily installed in either vertical or horizontal pipe line.

SEND FOR BULLETIN 177 TO:

R. P. ADAMS CO., INC. 209 EAST PARK DRIVE BUFFALO 17, N. Y.

Circle 26A on reply card

Circle 27A on reply card

DON'T BE SATISFIED WITH HALF-WAY MEASURES...

insist on Walseal® products and be certain

— the FACTORY INSERTED Ring insures FULL PENETRATION of the Silver Alloy . . . a perfect joint

Today, contractors . . . builders . . . architects are using brazed connections, in ever increasing numbers on their brass and copper pipe runs. However, they must be certain that the correct brazing alloy is used; that the joint has penetration of alloy up the shoulder of the fitting.

That's why more and more are turning to Walseal joints made only with Walseal valves, fittings and flanges which assure the proper amount of alloy with no waste. They know that the finished joint not only will withstand hydrostatic pressure, but it will also withstand terrific impact and vibration – in fact, no correctly made Walseal joint has ever been known to creep or pull apart under any pressure, shock, vibration or temperature which the pipe itself can withstand.

Furthermore, it is a relatively simple operation to make a joint – no heavy scaffolding need be erected . . . just cut the pipe, flux, assemble, then braze, following the technique recommended by the Walworth Company. A silver brazing alloy – FACTORY INSERTED – in each port flows out when heated with the oxyacetylene torch, making a joint that is stronger than the pipe itself . . . a one-hand operation, with the mechanic out of the path of the deflected heat – at all times.

For full information about Walseal joints made only with Walseal products, write for Circular.

WALWORTH

valves and fittings

60 EAST 42nd STREET, NEW YORK 17, N. Y.

SEE OUR CATALOG IN SWEET'S

WHERE EXPLOSIVES RESEARCH PAYS OFF

About 487,000,000 tons of coal were mined last year to provide fuel for America's electric utilities, coke ovens for producing steel and cement, and railroads. Mining that tonnage economically and efficiently required nearly a quarter billion pounds of industrial explosives.

Illustrated is one example of how explosives research pays off. The proper use of the right type of permissible explosive brought down a high percentage of lump, ready to be used with a minimum of processing.

Such results come from Hercules' continuous explosives research and extensive knowledge of field conditions. These are important factors in the economical and efficient blasting of coal, metals and nonmetallics, quarrying, and construction. Our technical representatives welcome the opportunity to consult with you on blasting problems.

HERCULES POWDER COMPANY
INCORPORATED

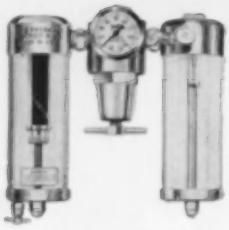
Explosives Department, 932 King St., Wilmington 99, Del.

Birmingham, Ala.; Chicago, Ill.; Duluth, Minn.; Hazleton, Pa.; Joplin, Mo.; Los Angeles, Cal.; New York, N. Y.; Pittsburgh, Pa.; Salt Lake City, Utah; San Francisco, Cal.

XR54-2

Prominent User Acclaims

"M-B" Automatic Air Line FILTER, REGULATOR and LUBRICATOR Assembly



The value of "M-B" Automatic Air Line Filters, Regulators and Lubricators is widely known for their effectiveness as a protection to Air Valves, Cylinders, Pneumatic Tools, etc.

"Your 'Sentinel of the Air Line' has been giving us very good service. We have had no complaints at all and I trust that we will be ordering more of them in the near future."

signed: **A. E. Cranston, Sr.**
PRESIDENT

Cranston Steel Strapping Co.
Oak Grove, Oregon

VISIT OUR BOOTH NO. 1439, A. S. T. E. SHOW, PHILADELPHIA, APRIL 26th TO 30th.

M·B PRODUCTS
46 Victor Ave.
DETROIT 3, MICHIGAN

Circle 30A on reply card

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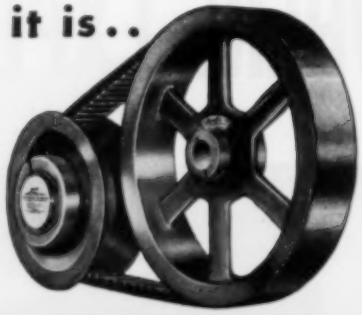
here it is..



New VARIABLE SPEED DRIVE
an easy, economical way to vary driven speed

By simply turning an adjusting screw, on either side of the sheave, both flanges move simultaneously and speed changes are obtained quickly and easily. Positive clamping of the two adjustable flanges eliminates fretting corrosion. Single wide range belt for motors 5 to 20 horsepower provides speed range ratios up to 3 to 1 . . . no lubrication . . . less shaft overhang . . . sensibly priced and economical in operation . . . send for Bulletin #796 for detailed information.

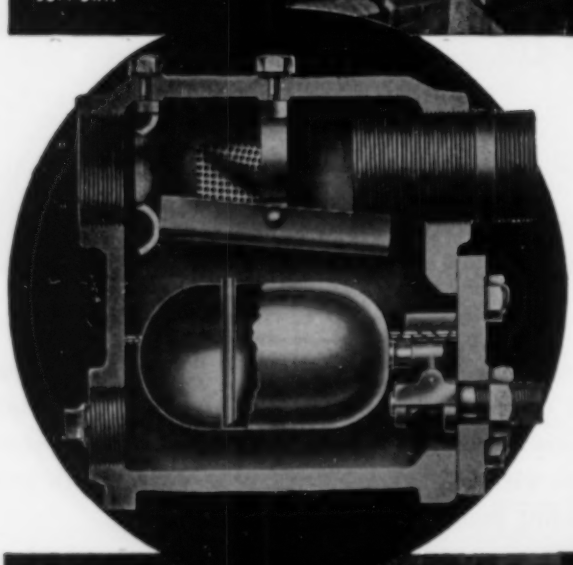
T. B. Wood's SONS COMPANY
CHAMBERSBURG, PA.
Mechanical Power Transmission Manufacturers—Since 1857.

CAMBRIDGE, MASS. • NEWARK, N. J. • DALLAS, TEXAS • CLEVELAND, O.

Circle 31A on reply card

DRI AIR MAY BE INSTALLED BY SUSPENDING IT FROM THE PIPING WITHOUT ANY OTHER SUPPORT.

INCREASED PNEUMATIC EFFICIENCY WITH THIS AUTOMATIC SEPARATOR



PROTECT EQUIPMENT WITH

DRIAIR

SEPARATES • COLLECTS • DELIVERS

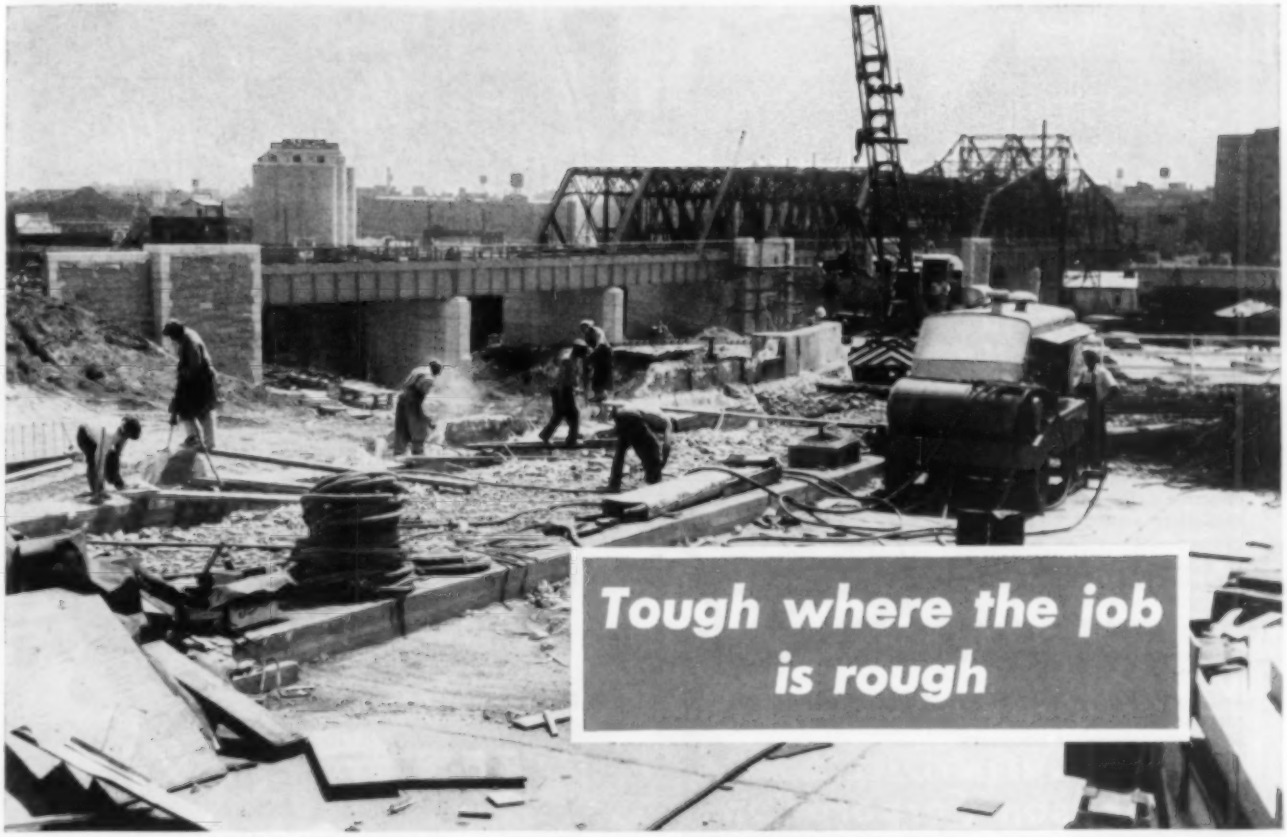
• DriAir separates and automatically ejects the condensed water and oil from compressed air lines, collects pipe scale and rust, delivers clean dry air to tools and other pneumatic equipment. This promotes better lubrication, reduces wear, increases life of tools and produces greater output. All internal parts are made of bronze or copper—resistant to corrosion and practically permanent.

A TYPICAL INSTALLATION SHOWING DRI AIR STANDING ON A CONCRETE FLOOR NEXT TO THE WALL.

WRITE FOR BULLETIN DA WHICH FULLY DESCRIBES THE CONSTRUCTION AND OPERATION OF THE DRIAIR.

NEW JERSEY METER CO.
"SPECIALISTS IN COMPRESSED AIR DEVICES"
PLAINFIELD, NEW JERSEY

Circle 32A on reply card



Air hose with tube and cover of NEOPRENE takes hard grind of pavement breaking

Pushing aside old roads to make way for new and better ones—that's the rugged job of pavement breaking. It's work that demands the best from men and equipment. For example, the air hose that supplies "drive" for paving breakers must stand up to extra-rough punishment . . . day-after-day abrasion from sharp rocks, broken concrete and sandy soil. Its cover is subjected to blistering sunlight, the tube to hot lubricating oil. But here's an air hose that can take it, and bounce back ready for more! It's made inside and out with Du Pont neoprene.

THE COVER OF NEOPRENE is tough and durable . . . resists abrasion, cutting and chipping throughout its long life. And, because neoprene can withstand the deteriorating effects of sunlight, heat and weathering, the fabric reinforcement receives maximum protection.

THE NEOPRENE TUBE won't go to pieces when exposed to hot lubricating oil in the air stream. No crumbled particles from the tube are carried along to clog vital tool parts. And neoprene's toughness and flexibility assure long, trouble-free service under the most adverse conditions.

DU PONT SUPPLIES neoprene to air-hose manufacturers who use it in their top-quality lines. Ask your supplier about hose with tube and cover of neoprene. He'll be glad to show you how it's built for rugged service.

FREE! The Neoprene Notebook. Each issue brings you new, unusual applications of neoprene . . . new products . . . interesting stories. Send in the coupon below to get on the mailing list.

NEOPRENE

The Rubber Made by Du Pont Since 1932

DU PONT

REG. U. S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING . . . *THROUGH CHEMISTRY*

E. I. du Pont de Nemours & Co. (Inc.)
Rubber Chemicals Division CA-4
Wilmington 98, Delaware

Please put me on the mailing list for the Neoprene Notebook.

Name_____ Position_____

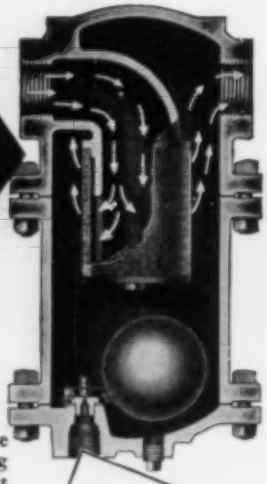
Firm_____

Address_____

City_____ State_____

Circle 33A on reply card

NO MOISTURE OR DIRT GETS BY HERE



Johnson Self-Draining Compressed Air Separator.....

Like all Johnson Separators the new Type "SA" Self-Draining Separator combines the two most effective principles of removing moisture and dirt from compressed air:

1. Controlled expansion of air in separator precipitates most of the moisture.
2. A "thousand baffles" of coarse mesh repeatedly changes flow of direction to capture remaining foreign matter.

Johnson Separation Devices include Separators for Compressed Air or Steam, After coolers, oil absorbers.

Self-Draining—a simple but complete trap mechanism built right in, automatically drains separator whenever necessary.

WRITE FOR CATALOG

The Johnson Corporation

830 WOOD STREET THREE RIVERS, MICH.

Circle 34A on reply card

Leaking Air is an expensive luxury

If you can't afford it,

HILLS-McCANNA Saunders Patent diaphragm valves will put an end to it!

WRITE FOR LITERATURE

HILLS-McCANNA Saunders Patent diaphragm valves

HILLS-McCANNA COMPANY, 2361 Nelson Ave., Chicago 18, Ill.

Circle 35A on reply card

AMAZINGLY SUPERIOR BEARING BRONZE

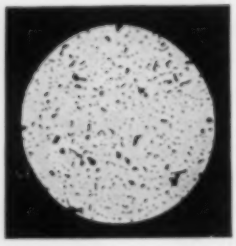
BEARIUM METAL

The unique structure of Bearium Metal combines not only the best features of babbitt and bronze, but, in addition, has desirable frictional characteristics that are exclusive.

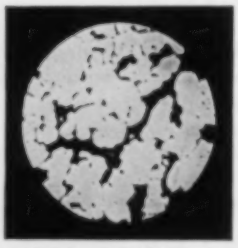
★ It will not melt out like babbitt.

★ It does not score like an ordinary bronze.

★ It definitely puts an end to all problems ordinarily encountered in frictional applications.



BEARIUM METAL magnified 25 diameters shows lead (black) in microscopic, globular form, uniformly distributed.



ORDINARY LEADED BRONZE at 25 diameters shows poor lead distribution, with lead between copper grains.

Write for Full Information on this Amazing Bearing Alloy

BEARIUM METALS CORP.

270 State St., Rochester 14, N. Y.

WEST COAST AFFILIATE:
Nevin Engineering Associates
932 Chautauqua Blvd.
Pacific Palisades, Calif.

IN CANADA:
Bearium Metals of Canada, Ltd.
155 George St.
Toronto 2, Canada

Circle 36A on reply card

PROTECT Compressed Air Systems

QUICK FACTS

1. AUTOMATIC DRAINAGE. Armstrong Air Traps work automatically. They stay on the job 24 hours a day to protect equipment against water damage.
2. AIR SAVINGS. Compressed air costs money. Armstrong Air Traps blow down condensate without wasting air. No worry about hand operator failing to close valve.
3. TROUBLE-FREE PERFORMANCE. Armstrong offers Air Traps for every purpose. The line is complete with types to handle toughest jobs.
4. LOW COST, HIGH QUALITY. Stainless steel trim. On a capacity basis they can't be beat.
5. RECOMMENDATIONS. Complete information and recommendations on request. ARMSTRONG MACHINE WORKS, 885 Maple St., Three Rivers, Mich.

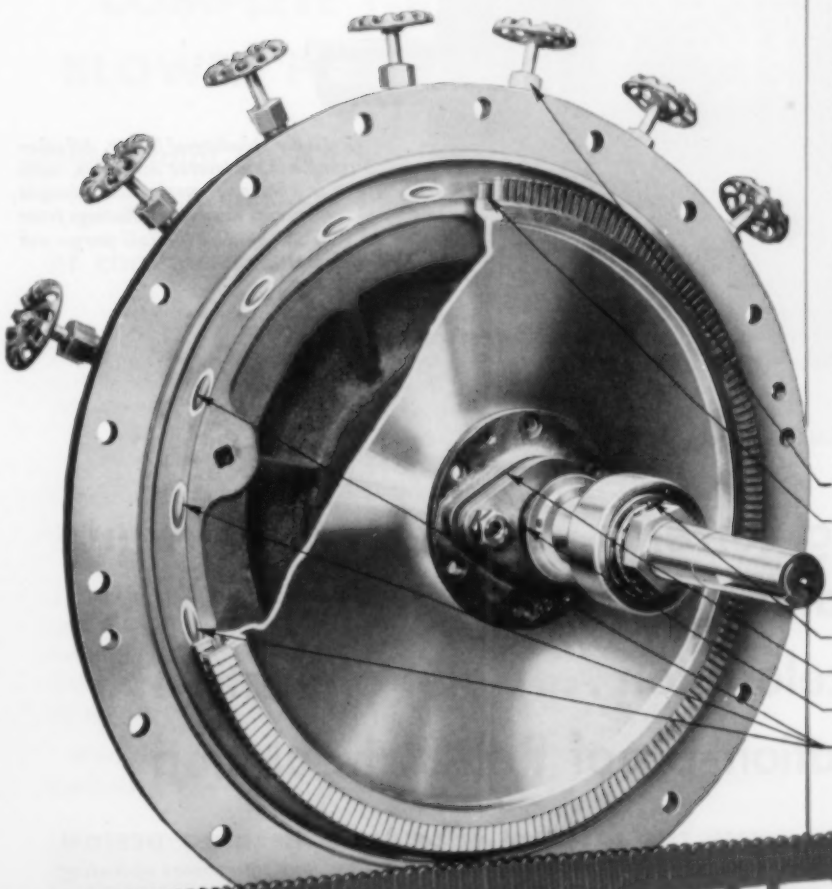
ARMSTRONG AIR TRAPS

Circle 37A on reply card

No other steam turbine offers you

SUCH VERSATILE STEAM NOZZLE CONTROL

The larger number of hand valves you see on a Coppus Steam Turbine promises you greater operating economy. At least 60% of the steam nozzles can be individually controlled to give maximum steam pressure in steam chest . . . a guarantee of best water rates at any load. Maintenance economy, too, is assured by the hard chromium plating of the shaft at the stuffing box. It provides the best possible smooth, non-corrosive surface for packing rings.



- 7 hand valves for efficient partial load operation, (20" turbine shown)
- 2 row velocity-stage turbine wheel with stainless steel turbine buckets — statically and dynamically balanced
- 30-40 carbon steel shaft
- Oversized double row deep grooved ball bearing
- Stuffing box with metallic packing ring
- Heavy chrome plating of shaft through stuffing box
- 3 nozzles always open

Coppus Steam Turbines, Type TF, driving chemical transfer pumps at Celanese Corporation of America's Chemcel Plant

Coppus Steam Turbines ranging from 150 hp down to fractional in 6 frame sizes

MAKE TURBINE DOLLARS GO FARTHER

Why waste money buying turbines with higher horsepower ratings than you need? The higher the horsepower rating, the higher the price. Save money by selecting the Coppus Turbine size closest to your requirements from 150 hp down to fractional. And when you do, you save operating and maintenance costs, too. That's what these other Coppus features are designed to do: exclusive pilot operated excess speed safety trip supplementing constant speed governor; choice of metallic or carbon ring packing assemblies. Designs available for back pressures up to 75 pounds; replaceable cartridge type bearing housings. For full details . . .

WRITE FOR BULLETIN 135

COPPUS ENGINEERING CORP.,
204 Park Avenue, Worcester 2, Mass.
Sales offices in THOMAS' REGISTER.

COPPUS "BLUE RIBBON" TURBINES

Circle 38A on reply card

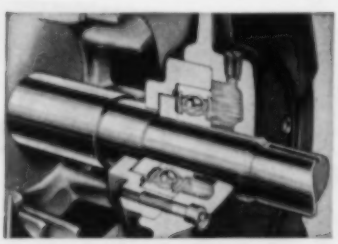
FOR COMPRESSOR SERVICE...

"All motors are NOT alike!"

RELIANCE *Precision-Built* **MOTORS**

Reliance Splashproof Motor. All other standard enclosures available, with wide choice of mechanical designs, and special mountings. Ratings from ¾ to 300 hp. Get the full story—ask for Bulletin B-2101.

- ☆ Low starting currents... high starting torque ...liberal ratings
- ☆ Smooth acceleration ... quiet operation
- ☆ Tough, vibration-proof Reli-X insulation



... AND THE BEST PRE-LUBRICATED BEARING DESIGN

The Reliance pre-lubricated bearing provides *four times more operating hours without re-lubrication* than any other bearing used in motors today. And—whatever your lubrication schedule—*you just can't grease 'em wrong!* To get the complete "inside story" on motor bearings, write today for Bulletin B-2201. It contains hard facts on the advantages of the Reliance pre-lubricated bearing design, with cutaway view, cross-section diagram, comparison chart, and statements by bearing manufacturers. B-1458C

RELIANCE ELECTRIC AND ENGINEERING CO.

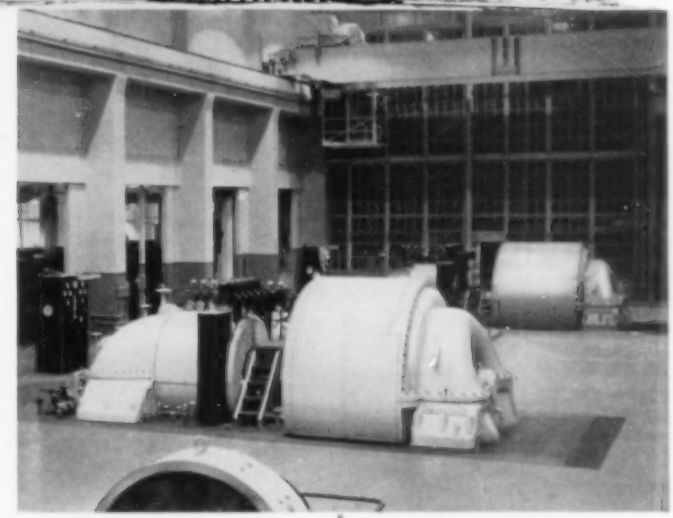
1118 Ivanhoe Road, Cleveland 10, Ohio • *Sales Representatives in Principal Cities*

Circle 39A on reply card

AT KAISER FONTANA STEEL PLANT

FOUR COMPLETE I-R BLOWER PLANTS*

with a total rated capacity of 350,000 cubic feet of charging air per minute



Two of the four Ingersoll-Rand Turbo-Blowers installed in the furnace blowing room of the Kaiser Fontana Steel Plant.

Ingersoll-Rand Turbo-Blowers driven by I-R Steam Turbines and served by I-R Surface Condensers, Air Ejectors and Condensate Pumps

It takes a lot of air to keep the blast furnaces burning at the huge Kaiser plant. And *all of it* is supplied by Ingersoll-Rand Turbo-Blowers.

The I-R blower equipment at the Fontana Plant includes two 100,000 cfm and two 75,000 cfm steam turbine driven Turbo-Blowers, each served by I-R rectangular surface condensers, steam-jet air ejectors and condensate pumps. These complete I-R Blower Plants, with all elements designed to work together as a unit, provide the *maximum dependability* for continuous heavy-duty service, year after year.

When it comes to blast furnace blowing, Ingersoll-Rand's experience is unequalled. That's why I-R blast furnace turbo-blowers are first choice in America's steel plants. Your nearest Ingersoll-Rand engineer will be glad to tell you more about I-R turbo-blowers. Ask for your copy of catalog 8258.

OTHER I-R EQUIPMENT SERVING THE KAISER PLANT AND EAGLE MOUNTAIN IRON ORE MINE

- Gas-Engine-Driven Compressors
- Electric Driven Compressors
- Centrifugal Pumps
- Wagon Drills
- Air Tools
- Paving Breakers

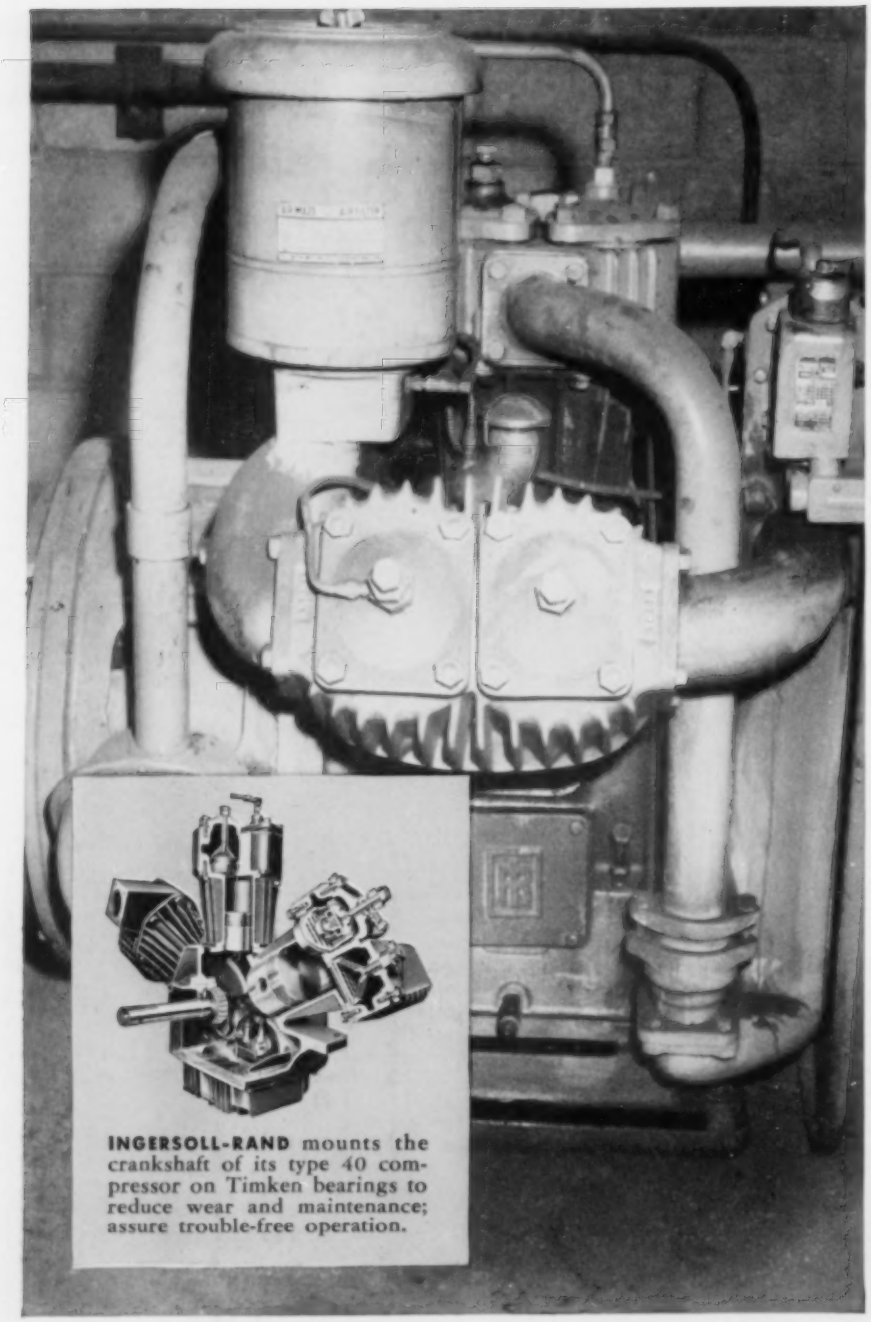
Ingersoll-Rand

11 Broadway, New York 4, N. Y.

14-34

Circle 40A on reply card

New York cleans up with help of Ingersoll-Rand compressor and TIMKEN® bearings



INGERSOLL-RAND mounts the crankshaft of its type 40 compressor on Timken bearings to reduce wear and maintenance; assure trouble-free operation.

THIS Ingersoll-Rand type 40 compressor powers the air-type grease guns that help keep New York's garbage wagons on the go. And with Timken® tapered roller bearings on the compressor's crankshaft, New York cleans up even more. Wear is reduced, maintenance costs are cut and long life assured.

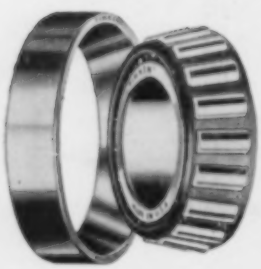
Timken bearings reduce wear because their true rolling motion and incredibly smooth surface finish practically eliminate friction. And because the tapered construction of Timken bearings enables them to take any combination of radial and thrust loads, the crankshaft is held in positive alignment.

Timken bearings keep housings and shafts concentric—making closures more effective in keeping dirt out, lubricant in. As a result, maintenance costs are held to a minimum.

Timken bearings handle the crankshaft loads with ease. Full line contact between rollers and races gives Timken bearings extra load-carrying capacity.

To get all these advantages in the equipment you build or buy, always specify Timken tapered roller bearings. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ont. Cable address: "TIMROSCO".

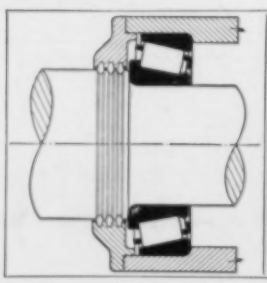
This symbol on a product means its bearings are the best.



TIMKEN

TRADE-MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS



LUBRICANT STAYS IN —DIRT KEPT OUT

Because Timken bearings hold shafts concentric with housings, closures are made more effective. Lubricant is retained, dirt and moisture kept out.

The Timken Roller Bearing Company is the acknowledged leader in: 1. advanced design; 2. precision manufacture; 3. rigid quality control; 4. special analysis Timken steels.

NOT JUST A BALL NOT JUST A ROLLER THE TIMKEN TAPERED ROLLER BEARING TAKES RADIAL AND THRUST LOADS OR ANY COMBINATION

Circle 41A on reply card